BIRTH BEHAVIOR AND LAMB SURVIVAL IN MOUNTAIN SHEEP IN ALASKA

A

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BIRTH BEHAVIOR AND LAMB SURVIVAL IN MOUNTAIN SHEEP IN ALASKA

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ABSTRACT

Birth behavior and lamb survival were studied in a population of Dall sheep (Ovis dalli kenaiensis Allen) on the Kenai Peninsula during 1966 and 1967. In 1966, lambs constituted 26%, and, in 1967, 17% of the total population. The lamb to ewe ratio in early summer was 64:100 in 1966 and 46:100 in 1967. Survival to yearling age of the 1965 lambs was 88%. Survival of the 1966 lambs to 1967 was at least 66%.

Lambing extended from about 20 May to 23 June in 1967. The majority of the lambs were born during the first 2 weeks of lambing. Parturient ewes sought the security of high, usually south-facing, cliffs as much as 12 hours before birth. Activities by ewes before parturition were oriented around a birth bed, and it remained the focus of activity for ewe and lamb for 8–12 hours after birth.

Ewes appeared to have an instinctive motivation to paw their lambs with their forefeet soon after birth. This pawing was first seen 6 minutes after birth and was repeated often during the period 8–10 minutes after birth. Licking of the lamb by the ewe was almost continuous during the activity periods immediately after birth. Neonatal play began soon after birth and continued throughout the first day of life. Regular nursing during each activity period began about 3 hours after birth. Ewes resumed feeding soon after the regular nursing pattern began. The behavior pattern of ewe and lamb stabilized around feeding excursions and consisted of arousal, nursing, feeding, and following.

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METHODS OF OBSERVATION

Field studies on Surprise Mountain were conducted on the following dates: from 14 July 1966 to 27 August 1966, from 20 November 1966 to 26 November 1966, from 10 March 1967 to 19 March 1967, from 12 May 1967 to 27 June 1967, and from 14 July 1967 to 8 September 1967. Lambing observations were made during only one lambing season, that of 1967, from 25 May 1967 to 27 June 1967. During those 34 days fog prevented observations on 11 days (32% of period). Thus, the lambing observations in this study were made on 23 days during the 1967 lambing season.

All lambing observations were made from the top of cliffs above the sheep, and in most cases they were apparently unaware of the observer's presence. All parturient ewes and ewes with newborn lambs observed were kept under continuous observation for as long as possible in order to determine the behavioral profile of ewe and lamb at birth and throughout the first day of the lamb's life. The sheep were observed through a tripod-mounted, monocular spotting scope (15-60 variable power) and 10x40 binoculars. Observations were recorded on a small, portable tape recorder. A 35 mm camera with 50 mm and 135 mm lenses was used for general record-keeping.

I tried to reconnoiter the lambing cliffs at least every 24 hours, weather permitting, to determine the schedule of appearance of the lambs. Observations indicated that ewes with new lambs remain in the isolation of the high cliffs for 12-24 hours or more after birth and are usually identifiable through behavior patterns described

later. Thus, such surveys over the lambing cliffs provided information on births that might have occurred up to 12-24 hours prior to the survey. Lamb counts were made on 6 June, 16 June, 25 June, and 26 June to further document the schedule of appearance of the lambs.

Information on the sheep population structure was obtained through ground and aerial counts. Various techniques of ground counting were used, depending on the distribution of the sheep in the particular season and the objective of the count. Aerial counts were made by experienced observers (Troyer and Richey in 1966, Troyer and me in 1967) in a two place supercub. One count was a combined ground-aerial effort in which an aerial observer located the bands of sheep and by radio directed a ground observer to them for determination of their sex and age composition.

PART I

THE STUDY POPULATION

History

The sheep population size on Surprise Mountain from 1949 to 1967 is shown in Fig. 1, as determined by annual aerial counts made by the personnel of the Kenai National Moose Range. The population has undergone a fivefold increase (from ca. 50 to 250 sheep) over this period. The sheep population for the same period on the entire Kenai National Moose Range, including Surprise Mountain, is shown in Fig. 2, and illustrates a similar fivefold increase (from ca. 200 to over 1,000 sheep). No census data are available for the decade prior to 1949, but the Surprise population was thought relatively high in the early forties, with a major reduction occurring in the mid-forties and a slight increase thereafter (Refuge Narrative Report: Kenai National Moose Range, 1966). Severe icing conditions existed during several winters of the mid-forties (Refuge Narrative Report: Kenai National Moose Range, 1966).

Sheep populations all over the state of Alaska followed a similar trend: still relatively high in 1940, but rapidly declining thereafter—reaching a low point about 1945 and slightly increasing to 1950 (Scott et al., 1950:613). Murie (as discussed in Buechner, 1960:114) offered an interesting explanation for this population drop in Mount McKinley National Park. He believed that in 1941, due to a combination of factors, the population had an old age structure. The

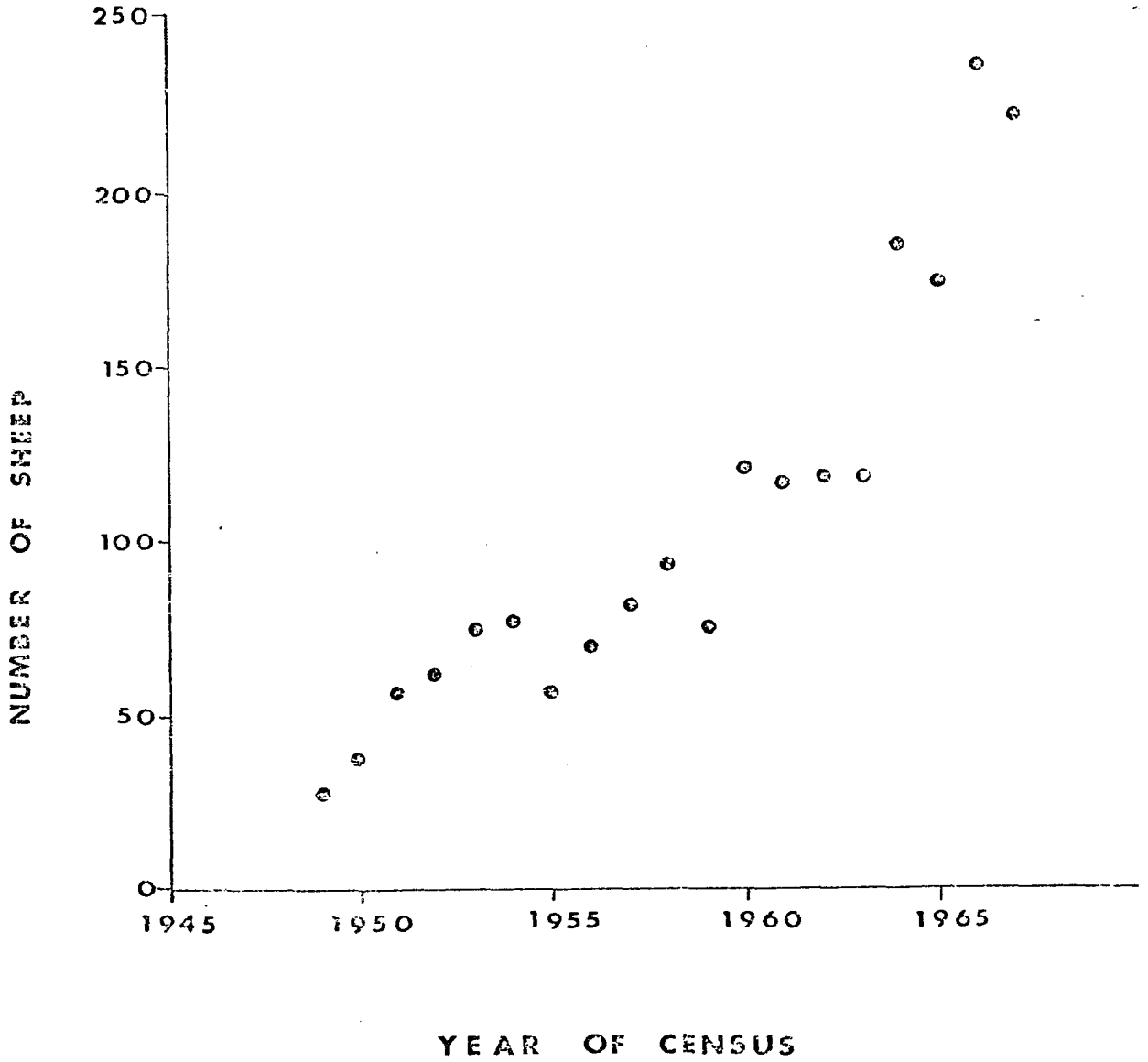


Fig. 1. The sheep population size on Surprise Mountain as determined from aerial counts 1949-1967.

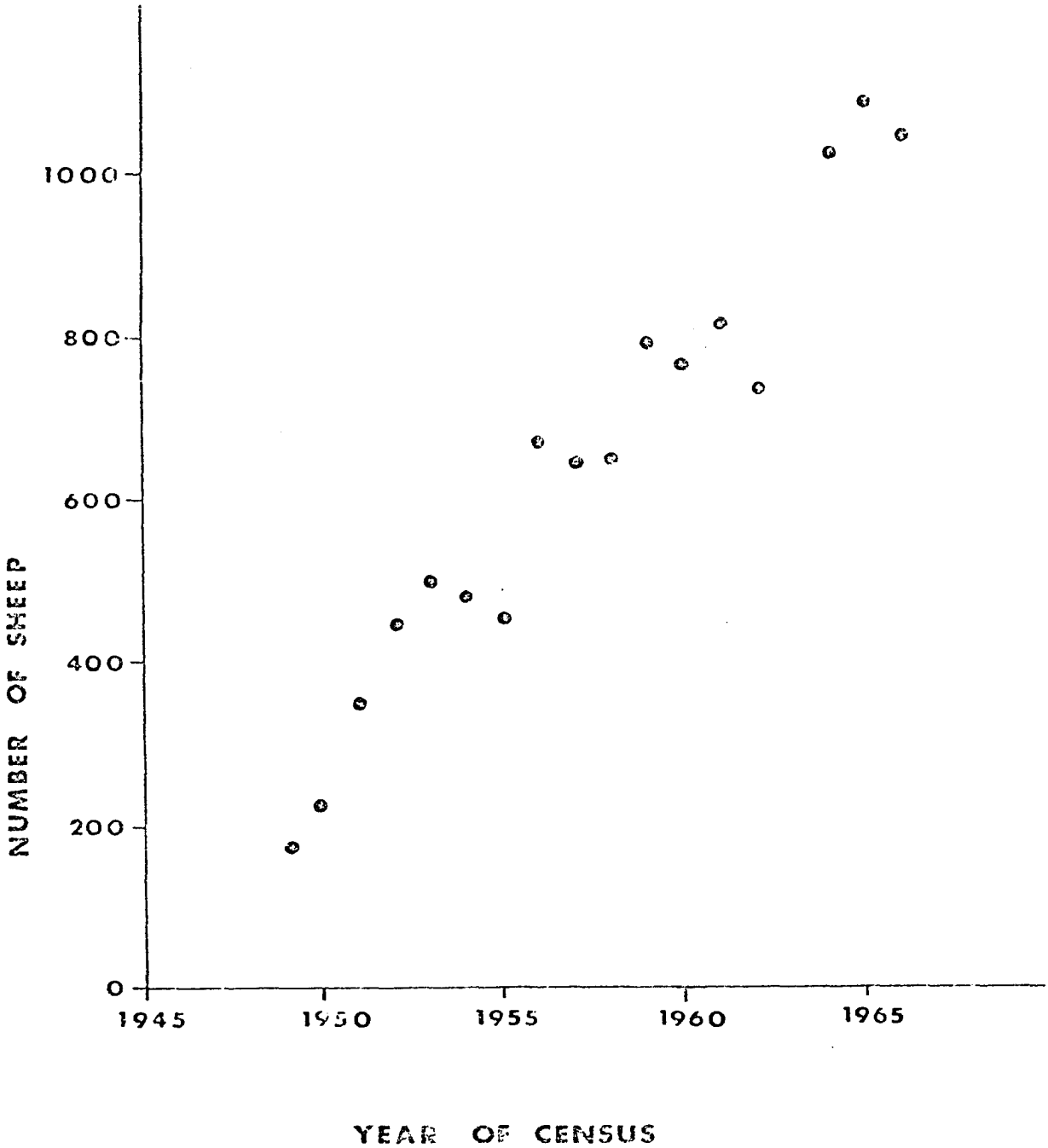


Fig. 2. The sheep population size on the Kenai National Moose Range as determined from aerial counts 1949-1966.

heavy mortality during the winter of 1931-32 was thought to have affected the unborn lambs, yearlings, and old individuals more than other age groups, thus (1960:114) "...leaving a poststarvation population high in number of individuals in the two- through four-year age groups." Wolf predation on lambs during the next decade was assumed to have kept the population from increasing, and the decline between 1941 and 1945 resulted from the old individuals dying off. Murie's interpretation is not mentioned as an explanation for the population drop on the Kenai Peninsula where wolves are for all purposes extinct, but merely as a good example of how a knowledge of the history of a population may be necessary to interpret the population dynamics at a later time. It is possible for a similar process to have occurred on the Kenai Peninsula in the absence of wolves. Scott (1950:616) thought the coyote, abundant on the Kenai Peninsula by the late-thirties, was an important predator of sheep. Or a decade of relatively severe winters might have followed a large loss in the winter of 1931-32. Such severe winter conditions may have resulted in poor lamb crops and low recruitment to the population (without visibly affecting the adult sheep)—resulting in a similar old age structure by 1941.

A hunting season for three-quarter curl rams was reopened in 1956, after closure for about a decade, and has continued each year since then. The hunting season now extends from 10 August to 20 September. Because of easy accessibility, the Surprise population is subject to heavy hunting pressure. At present most rams are harvested soon after they reach legal size. The oldest ram taken in the 1966 and 1967 hunting seasons was 5 years old, and no older rams were

observed in the population. The effect of hunting presents certain difficulties in a study of the Surprise population. The sheep know man as a hunter and, therefore, are very difficult to approach and observe. The observer must take special precaution to hide himself from the sheep to insure their undisturbed observation.

The large number of sheep in the population in 1966 and 1967 made it difficult to identify individuals; however, the large population and high production increased the chances of observing parturition and related behavior.

Habitat

Surprise Mountain (60° 25' N, 150° 05' W) includes about 13 square miles of alpine habitat (see Fig. 3). Perhaps the most unique aspect of the physiography of this mountain is its isolation from nearby sheep ranges by wide wooded valleys, rivers, and lakes: to the south and west by Skilak River and Skilak Lake, to the north and west by the Kenai River, and to the east by the Russian River and Lower Russian Lake. All of the surrounding mountains now have sheep populations and, although under certain conditions movements may occur from Surprise to these mountains, such movements do not appear to be a part of the annual pattern of range use for the Surprise population. Surprise Mountain is composed of three separate peaks: Russian Mountain (el. 4,300'), Bear Mountain (el. 3,700'), and Skilak Mountain (el. 4,113'). Of particular importance in this study are the Skilak Cliffs, which comprise the southwest face of Skilak Mountain (see Fig. 3). The Skilak Cliffs extend for about 1 mile along this face of the mountain and are separated from the less-rugged slopes to the west and east by rocky escarpments. Six or seven of these rugged escarpments extend from the top to the bottom of the Skilak Cliffs and lend a broken, rugged quality to them. This quality distinguishes these cliffs from the arc of cliffs that extend east from them to Lamb Gulch, a distance of about 3 miles (see Fig. 3). These cliffs are just as steep as the Skilak Cliffs, but are not so rugged.

Most of the lambs are born in the Skilak Cliffs and spend the first weeks of life close to such secure terrain. The Skilak Cliffs are also a preferred escape terrain for the entire population, and

Fig. 3. Map of the Surprise Mountain study area. (Note that this area can be located on a large scaled map off the eastern end of Skilak Lake.)

Map from U. S. Geological Survey, Alaska Reconnaissance Topographic Series, 1950, Kenai Quadrangle, Scale 1 inch = 1 mile.

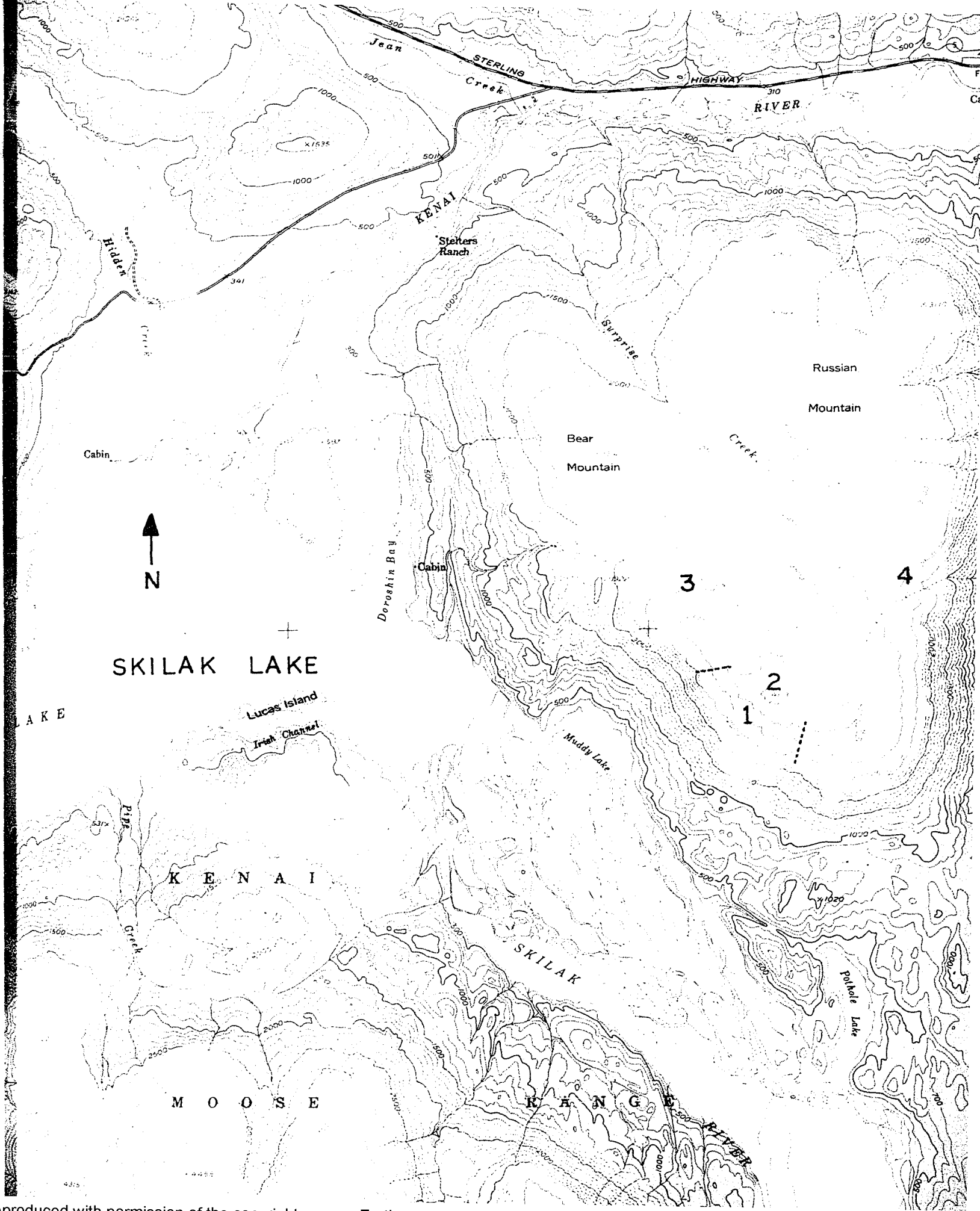
Legend:

1 = Skilak Cliffs (area within broken lines)

2 - Skilak Mountain

3 - Skilak Creek

4 = Lamb Gulch



the sheep will usually flee toward these cliffs when in their vicinity. I took advantage of this habit during two lamb counts on 16 June and 26 June and counted the sheep as they fled toward the Skilak Cliffs—practically eliminating the possibility of double counting. I wanted an accurate estimate of how many lambs were present, and, as most of the lambing was completed, I thought such information worth the risk of disturbing the sheep. Another example of the security the Skilak Cliffs afford is provided by a ram wounded during the 1967 hunting season. He sought out the very area just below the Skilak Peak, where many lambs were born, and rested there for at least 5 days.

The climate of the Surprise Mountain area is colder and drier than the mild, moist coastal climate of Seward. This pattern influences the sheep distribution in the Kenai Mountains, as sheep are absent from the coastal side where winter snows are apparently too deep for them. Klein (1953:32) described the general weather patterns of this area:

> Most storms come from the direction of the Gulf of Alaska, although during the winter months storms originating in the Bering Sea region penetrate the area. Cloudy weather prevails during much of the year with clear skies being more common during late winter and spring. Winds are common as a result of cold air drainage from the Harding Ice Field. Southerly winds blowing from the ice field and Blying Sound prevail throughout the spring, summer, fall, and early winter. During late winter the snow mantle over the remainder of the peninsula diminishes the effects of the ice field and fewer storm tracks are from the south; cold air drainage from the mainland of Alaska during this time, however, results in northerly winds on the Kenai Peninsula.

During the spring of 1967 the weather changed abruptly from 3 weeks of fair weather to a month of predominately cloudy, stormy weather.

During the 21 days from 9 May to 29 May, clear skies prevailed on 20 days (95% of period). During the 31 days from 30 May to 29 June, cloudy, stormy weather prevailed on 19 days (61% of period). Strong winds from the ice field are common during such storms. These winds strike Surprise Mountain on the southeast corner. As the air rises, a fast-moving layer of fog often forms that travels up and over the mountain in a northwesterly direction. Such fog can effectively veil the entire southeast corner of the mountain above the 2,500 foot level (including the Skilak and Russian River Cliffs), while the ceiling remains much higher over the surrounding valleys. This fog is very frustrating to the observer, but probably places potential avian predators at a disadvantage, also.

The timber line on Surprise Mountain occurs at about 1,500 feet elevation. Above the timber is a well-developed zone of alder (Alnus crispa) that forms almost impenetrable thickets. This zone varies in width with exposure and local climatic conditions, but extends up to the 2,000-2,500 foot level on most slopes. At the upper fringe of the alders, in areas of drainage or seepage and especially on south-facing slopes, woody shrubs such as bog blueberry (Vaccinium uliginosum), dwarf birch (Betula nana), and willow (Salix spp.) are common. Above the alder zone, from about the 2,500 foot elevation and up, the vegetation consists of low alpine tundra, although shrubs such as willow and dwarf birch follow the creek beds to higher elevations. Stands of vegetation in the alpine zone are distributed in a "...mosaic of patterns that is determined by slope, elevation, exposure, parent material, relation to snow cover and wind exposure, and other environmental factors (Viereck, 1963:13)." Grasses, sedges,

and forbs (such as dwarf willows) are sparsely distributed throughout, and are locally abundant in the deeper soil pockets or in soils fed by drainage from higher elevations. These forms even grow in the deeper soil pockets of the driest areas on the mountain, such as the rock screes of the Skilak Cliffs. The availability of such forage in the lambing cliffs is undoubtedly an important factor in the pattern of activity of ewe and neonatal lamb soon after birth when the ewe resumes feeding.

The mammalian fauna of Surprise Mountain includes the following relevant species: moose (Alces alces), black bear (Ursus americanus), brown bear (Ursus arctos), coyote (Canis latrans), lynx (Lynx canadensis), hoary marmot (Marmota caligata), and wolverine (Gulo luscus). An occasional mountain goat (Oreamnos americanus) wanders onto the mountain, but rarely stays for more than a week. Human activity in the area is minimal, except during the hunting season. During the lambing season of 1967, the only people observed were fishermen on the surrounding lakes. Relevant members of the avifauna include the golden eagle (Aquila chrysaetos), bald eagle (Haliaeetus leucocephalus), raven (Corvus corax), magpie (Pica pica), and willow, rock, and white-tailed ptarmigan (Lagopus spp.).

Population dynamics: 1966 and 1967

Size and composition:

Results of ground and aerial counts of the Surprise Mountain population in 1966 and 1967 are given in Table 1. The results represent minimum numbers because some groups are missed and large groups are usually underestimated. In aerial census it is also difficult to spot lambs that stand close to or under their ewes.

The 30 May 1966 count was made by Detlef Eisfeld, a graduate student at the University of Alaska. The combined ground-aerial technique of the 25 August 1966 count proved the best method of counting the sheep when on the summer range. At this time the sheep may be distributed throughout the entire alpine area of the mountain, making ground census difficult without aerial reconnaissance. Hunters had harvested six rams and one ewe by the time the count was made. The 15 May 1967 and 24 May 1967 counts are examples of the large numbers of sheep that often gathered on the southeast corner of the mountain at this time of year. The latter is a census of virtually the entire population. Both were made from below the sheep by a stationary observer without the necessity of disturbing them. The 6 June 1967 count was an attempt to determine the number of lambs present at this time. This count was made by surveying the Skilak and Russian River Cliffs in the evening (between 1800 and 2000) when most ewes with young lambs had returned to the higher portions of the cliffs for the night. This behavior of ewes with young lambs is noted by other investigators also (Welles and Welles, 1961:130) and is discussed in Part II. The technique employed on the 16 June 1967 and 26 June 1967

TABLE 1. COMPOSITION COUNTS OF THE SURPRISE MOUNTAIN SHEEP POPULATION IN 1966 AND 1967

Date, type of count	Ewes	Yearlings	Rams	Total adults	Lambs
5/30/66, ground		39			42
7/20/66, aerial	162		22	184	53
8/25/66, aerial-ground	162		27	189	66
5/18/67, ground	103	44	25	172	
5/24/67, ground	131	43	20	194	
6/6/67, ground					24-27
6/16/67, ground	163		32	195	36
6/25/67, ground					39
6/26/67, ground	153			153	39
7/28/67, aerial	154		37	191	31
9/8/67, ground				150-183	30-38

counts was mentioned previously. The sheep in these counts were also congregated on the southeast corner of the mountain, except for one small group which was west of the Skilak Cliffs in the 26 June 1967 count. All of the lambs in the 25 June 1967 count were resting in the Skilak Cliffs in the evening. The 8 September 1967 count was made as the basis for determining survival of lambs during the summer. One group of 33 adults and 8 lambs may have been counted twice, which explains the uncertain results. As 10 rams were harvested in 1967, the count of 183 adults, if correct, represents the entire population.

Eighty per cent of the lamb crop censused on the ground was recorded in the aerial counts each year. In 1966, 94% of the adults censused on the ground were recorded in the aerial count (184 vs. 196); in 1967, 99% of the adults were recorded in the aerial count (193 vs. 195). (Two adults died during the interval between the 16 June 1967 ground count and the 28 July 1967 aerial count and, therefore, are added to the aerial results.)

Population models:

One important population statistic that is not evident in the composition data of Table 1 is the number of breeding-age ewes (3 years and over) in the population in 1966 and 1967. Data are available on the size of the lamb crops of 1964 (19 lambs) and 1965 (44 lambs) from ground counts. The 39 yearlings present in 1966 indicate 88% survival of the 1965 lamb crop. Assuming survival of the 1964 lamb crop was virtually 100% (as the figure for the lamb crop seems unrealistically small), the number of 2-year-old sheep in the population in 1966 and 1967 can be estimated. Calculation of the number of breeding-age ewes (3-yr^{+}) in 1966 follows: 124 (189 total adults of

25 August 1966 count minus 27 rams of same count minus 39 yearlings of 30 May 1966 count plus one ewe killed by hunters before the August count = 124) minus 10 (2-year-ewes = 50% of 1964 lamb crop) minus 10 (2-year-rams = 50% of 1964 lamb crop) equals 104 breeding-age ewes. This calculation assumes that the 27 rams recorded in the 25 August 1966 count is too low and approximately all of the 2-year-old rams were missed. The same calculation for 1967 follows: 114 (195 total adults of 16 June 1967 count minus 37 rams of 28 July 1967 count minus 44 yearlings of 18 May 1967 count = 114) minus 20 (2-year-ewes = 50% of 1966 yearlings) minus 10 (2-year-rams = 25% of the 1966 yearlings) equals 84 breeding-age ewes. This calculation assumes the 37 rams recorded in the 28 July 1967 count is a better estimate of the number of rams present than that of the 1966 count, and, consequently, only 25% of the 1966 yearlings were subtracted as 2-year-rams. Population models for 1966 and 1967 based on these assumptions are given in Table 2. These models represent the adult population in each year before any summer mortality and the maximum number of lambs born each year.

Reproduction and lamb survival:

Although data from the aerial counts indicate lamb crops of between 10 and 20 lambs in the period 1957-1963, I believe that by 1963 the lamb crops were much larger than aerial counts indicated. In 1967, for example, I estimated that there were 12-15 4-year-old rams in the population--thus indicating a 1963 lamb crop of 25-30 or more lambs. This is further substantiated by noting the large increase in total population of 67 sheep between 1963 and 1964. The very large lamb crop of 1966 may further support this supposition, as the females

TABLE 2. MODELS FOR THE SURPRISE MOUNTAIN SHEEP POPULATION IN 1966 and 1967

Year	Ewes, 3-yr+	Ewes, 2-yr	Year-lings	Rams, 2-yr+	Lambs	Total adults	Total sheep	Lamb:ewe, 3-yr+
1966	104	10	39	43	67[a]	196	263	64%
1967	84	20	44	47	39	195	234	46%

[a]Includes one lamb killed during eartagging operations in spring of 1966.

of the 1963 crop would probably lamb for the first time in 1966. The 19 lambs censused in a 1964 ground count is probably a low estimate, also, as some 40 sheep were missed in this count that were censused in the 1964 aerial count. The 1965 lamb crop was 44.

In 1966, lambs constituted 26% (67/263) of the total sheep population; in 1967, they constituted 17% (39/234). In 1966, the lamb to ewe (3-yr^{+}) ratio in early summer was 64 lambs per 100 ewes; in 1967, it was 46 lambs per 100 ewes. The 39 yearlings present in 1966 indicated 88% survival of the 1965 lamb crop. Survival of the 1966 lamb crop, based on a minimum of 44 yearlings present in 1967, was 66% or better. Summer survival of the 1967 lamb crop was excellent (77-98%). Indications are that survival of the 1963 and 1964 lamb crops was also very good.

Murie's figures (1944:137) for lamb to ewe ratios include the 2-year-olds. He recorded spring ratios of 49% in 1939, 16% in 1940, and 54% in 1941. Similar unadjusted ratios for the Surprise population are 54% in 1966 and 34% in 1967. Murie (1944:137) thought that a 50% lamb crop was "...about what one would expect in a good year judging from the reproductive rates of big game in general." However, he thought the inclusion of 2-year-olds only changed the percentages a few points. The Surprise Mountain figures indicate that this may not be true in a rapidly growing population where the number of 2-year-olds is very large. Their inclusion changed the percentages 10-12 points. The adjusted ratios for the 1966 and 1967 lamb crops on Surprise Mountain appear to assess more accurately reproduction in these years. The 1966 crop appears exceptionally good for this population, and the 1967 crop is normal or a little below normal. Con-

sidering the very good production in 1966 and the good lamb survival (over 66%), some factor other than poor recruitment must have caused the population drop between 1966 and 1967.

Mortality:

Mortality is extremely difficult to document on Surprise Mountain because of the large number of scavengers present. Almost all of the birds and mammals mentioned previously are potential scavengers, but the black bear is probably the most efficient during spring, summer, and fall. Black bears are very numerous in the area. In a good berry year (such as 1967), it is quite common to see three or four black bears feeding on the eastern slopes of Russian Mountain where blueberries are common. The other scavengers that are equally capable of disposing of carcasses—the brown bear, wolverine, and coyote—are comparatively uncommon. Only a few individuals of each of these species were observed.

A black bear spotted guarding the carcass of an adult sheep during the aerial count on the morning of 28 July 1967 provides an example of their dispatch in removing all evidence of mortality. The next day I investigated the apparent "kill" on the ground. It was located 50 yards above alder level, just east of the Skilak Cliffs. The bear was still present but vanished into the alders as I approached. All that remained of the carcass was one set of hind-leg bones and a foot-long section of backbone, the bear having apparently cached the rest somewhere in the alders. Further evidence of the speed with which black bears locate carcasses was obtained during the hunting season of 1967. The site of every hunting kill was visited by black bears within several days of the kill. Many ravens, magpies, and

several golden eagles also were observed feeding on these remains. The fact that many black bears were observed below the Skilak Cliffs during May and June (one den with three cubs of the year was also located here) may relate to the availability of sheep carcasses (representing normal winter mortality as well as possible snow slide mortality) here in the spring.

There was some indication that wolverines may utilize winter-killed animals when the bears are in hibernation. During the field trip to the study area in March 1967, my field assistant, Finn Sandegren, tracked a wolverine and found sheep hair in the scats. During the trip we were unable to find any sheep carcasses, although Sandegren found some hide and stomach contents of an apparent winter-kill which were buried in a snowdrift.

During the summers on the mountain, I frequently (12 times) discovered small piles of winter sheep hair with hide attached, evidence of apparent winter-kills. This sort of evidence is not quantitative, however, as one carcass scattered here and there by scavengers can result in many such hair piles.

Predation:

No actual predation was observed during the study.

The black bear guarding the adult sheep carcass on 28 July 1967 was the only case of possible predation on sheep by black bears. As mentioned previously, black bears were frequently observed in and around the alder zone below the Skilak Cliffs. However, their usual zone of activity appeared to be the area low on the cliffs, and, therefore, they posed no threat to parturient ewes that sought safety high in the cliffs during lambing. The active den, which was located

in an alder thicket below the eastern end of the Skilak Cliffs, provided several opportunities for observation of the reaction of sheep that were feeding low on the mountain to the female bear as she made frequent feeding excursions away from the den. The sheep displayed a surprising indifference to her approach. Twice (on 12 May 1967 and 17 May 1967) groups of rams let her approach to within 25 yards before responding by slowly walking or trotting uphill for 5 or 10 yards, then resuming feeding. Sheldon (1960:78-79) described a similar indifference of a group of rams to the approach of a grizzly bear. On 6 June 1967 I observed a group of 10 adult sheep (located low on the Skilak Cliffs) calmly stand and watch a brown bear traversing the slope 30 yards below them. Murie (1944:107) described a similar lack of fear in sheep toward a lone wolf attempting to hunt them on a smooth, steep slope. The sheep, by running uphill, easily outdistanced the wolf. There was some indication that ewes with lambs only a few weeks old do not feel so confident when approached by black bears. On 13 June 1967 at 1930 a group of 10 ewes with lambs abruptly fled farther west in the cliffs. Ten minutes later a black bear was observed feeding on the slopes just vacated by the sheep. Only one black bear was observed above the Skilak Cliffs during lambing. It was feeding along the top edge of the cliffs on 6 June 1967. Four adult ewes that were resting 100 yards lower in the cliffs immediately stood up when they spotted the bear and nervously watched the bear until it fed out of view half an hour later.

A pair of brown bears, apparently courting, was observed several times in the Skilak Cliffs during 1-2 June. However, on three of the four observations they were at the bottom of the cliffs; one time they

were sleeping midway up the cliffs. Three of the four observations were of sleeping bears.

Golden eagles were very active in the study area in fair weather but were rarely seen on stormy days. Their abundance may relate to the high populations of marmots and ptarmigan on Surprise Mountain in 1966 and 1967. On 29 May 1967 I saw an immature golden eagle feeding on a freshly-killed marmot. Several times, while watching golden eagles cruise low over the cliffs in the spring, I saw ptarmigan burst into steep flight off the mountain in front of the eagles. The eagles never gave chase; apparently they were no match for the ptarmigans' rapid acceleration.

On one occasion I saw a golden eagle swoop low over a ewe with newborn lamb just a few hours old, coming within 3 feet of them. The dive elicited defensive rearing on hind legs of the ewe. The eagle landed about 20 yards uphill, remained there for 30 seconds, and then flew farther west in the cliffs. The incident appeared to make the ewe quite nervous. An hour later a magpie flying low along the cliffs happened to pass over the ewe, which again reared defensively over her lamb. Sheldon (1960:367) provided an almost identical description of a golden eagle swooping at two ewes with week-old lambs. The ewes stood over their lambs and "...thrust their horns upward at the swooping eagle." Sheldon reported that he frequently observed repetitions of this incident during the next 2 weeks. He also noted that on the appearance of an eagle, the ewes would rush to their lambs that might be 20 yards away and protect them. Murie (1944:98) reported similar observations of swooping eagles and noted, also, that lambs 3 or 4 weeks old do not appear worried by eagles. He said

that in late June he had observed eagles flying low over lambs separated from their ewes "...without attempting to strike and without alarming them." He concluded (1944:98) that the behavior of the ewe and lamb in the first few weeks offers adequate protection from eagle predation.

> During the first few weeks the lamb remains close to its mother. It usually lies down beside her when she is resting or lies down only a few feet away while she feeds. In traveling, the young lamb often presses close to its mother's side, sometimes appearing to be partially under her. The lamb is near its mother except when left with other lambs, usually on a cliff, while she goes off a short distance to feed. But at such times the group of lambs is watched over by some of the ewes. So, at the time when the lamb would be most vulnerable to eagle attack, it is generally well protected, giving the eagle little opportunity to prey on it.

One might view the eagle's habit of swooping at ewes with young lambs as a means of testing the maternal responsiveness of the ewe. A ewe in poor nutritional condition might not be so protective, and the eagles would get an easy meal.

Frequent disturbances of the sheep when the lambs are young may give the eagles a considerable advantage, also. During the lamb counts of 16 June 1967 and 26 June 1967, in which I censused the sheep as they fled toward the cliffs, many ewes became separated from their lambs. On 26 June 1967 six ewes left the Skilak Cliffs and proceeded back east from where they had fled, calling for their lambs. Four lambs also left the cliffs and returned east, looking for their ewes. During this count I also noticed an immature bald eagle fly low over the sheep as they fled west. Most of the lambs by this time were several weeks old, however, and not such likely prey. Buechner (1960:115-116) discussed possible golden eagle predation on young

lambs and concluded that while "positive evidence of eagles killing lambs has been noted on several occasions ....the available evidence is that such predation is incidental and does not control population levels."

Accidents:

On 21 June 1967 I found a dead 5-year-old ewe that had apparently been killed by a fall, as there was much clotted blood under the skin on her chest, forelegs, and at the base of her neck. She was found on the rocky escarpment that forms the eastern end of the Skilak Cliffs. It is a likely possibility that she fell when fleeing toward the cliffs during the lamb count on 16 June 1967.

One lamb with a lame right foreleg was observed on 18 July 1966 and again on 20 July 1966.

During the field trip to the study area in March 1967, I camped for several days (15-17 March) below and just east of the Skilak Cliffs to observe sheep (between 40 and 110 were always in sight) using the steep, south-facing meadows and cliffs in this area. During the observation period, many snow slides occurred, some of them quite large. Toward the end of the afternoon, these might occur approximately every half an hour. The sheep appeared quite aware of such dangers and would often cease feeding and alert to the sound of falling rocks loosened by other sheep. Some of the very large snow slides would send sheep feeding nearby scampering away. Many of these slides were started by sheep crossing the snow-filled ravines and surely represent a possible mortality factor. Geist (1967b:21) also described the nervousness of sheep feeding on south-facing cliffs during the spring avalanche season. The remains (horns and hind-leg

bones) of an apparent winter-killed, 4-year-old ewe were found below the cliffs in this area.

Senescence:

There is some evidence that the Surprise Mountain population contained many old ewes in 1966 and 1967, which suggests that high over-winter mortality among this group may have been responsible for the population drop. On 10 August 1967 a 12-year-old ewe remained resting while two hunters approached within 20 yards of her. She then rose, ran up a hillock, and fell over, dead. Her teeth were very worn, and she retained much of her winter coat at this late date. On 4 September 1967 another old ewe quickly fell behind a group of sheep fleeing from the observer. She soon slowed down to a walk, stopped for awhile, and then trotted slowly after the sheep which were by now 200 yards ahead of her. Other less direct evidence suggests that the population contained a large number of old ewes. I followed five individually identifiable old ewes throughout May and June of 1967. Not one of them had a lamb, suggesting either that they were past reproductive age or, because of their age, were not able to carry a lamb over the moderately severe winter of 1966-67. One of these ewes was the one just discussed that was not able to run when observed in September. The history of the population (males heavily hunted for 10 years), the composition (adults only 32% and 35% males in 1966 and 1967), the absence of a really effective predator (the wolf) to remove such old ewes, and the population drop in a year of good recruitment further suggest that the female age structure may have been heavy in old age animals in 1966 and had been considerably reduced over the winter. There was some indication that the winter

of 1966-67 may have been severe enough to cause the death of old animals. During the November 1966 field trip, Will Troyer was impressed with the poor range conditions (a layer of ice several inches thick covering vegetation in areas blown free of snow) as compared to the conditions existing the previous November. Late winter conditions appeared extremely favorable for the sheep, however, as much of the snow cover was gone from the south-facing cliffs in March 1967.

Mortality - discussion:

Considering the population models for 1966 and 1967 in Table 2, and the additional information presented about mortality possibilities, the following calculation considers the sex and age groups in which such losses may have occurred over the winter of 1966-67. The 1966 total sheep figure was 263 vs. 195 for 1967 (before lambing). Known summer mortality during 1966 was 8 sheep (255). If 20 yearlings were lost (235) and 20-25 old ewes (210-215), this leaves 15-20 sheep representing possible incidental mortality in the other age classes (plus some possible unreported hunting mortality). This calculation assumes that no sheep migrated from Surprise Mountain during the study period. This assumption seems reasonable in view of Geist's discussion (1967a: 24) of the importance of tradition in determining the daily and seasonal habits of a particular population of sheep. In this perspective any migration other than a regular, seasonal one is an unusual occurrence.

Lambing season

Some information on the beginning of the lambing season on Surprise Mountain is available for the past few years. In 1967, only two lambs were present on 25 May. In 1966, 13 lambs were counted on 24 May and 42 on 30 May. In 1968, 15 lambs were seen on 25 May. Therefore, it appears that lambing began at least a week later in 1967 than in 1966 and 1968. In 1965, the lambing season was thought to be very late on Surprise Mountain. An aerial census of 132 adults showed no lambs present on 4 June; another on 18 June counted 23 lambs and 136 adults; and a 2-3 July ground count recorded 44 lambs and 135 adults.

Murie (1944:130) noted that the majority of the lambs seem to be born in the first 2 weeks of the lambing period. In 1939 and 1941, most lambs in Mount McKinley National Park were born in the middle of May. However, in 1932 and 1940 the first lambs were not observed until about 1 June, and lambing was largely finished by the middle of June. Sheldon (1960:366) noted the first lambs in 1908 on 25 May and saw other new lambs on every day through 1 June.

Lambing - spring of 1967:

Observations of early spring feeding, lick use, and distribution - 12 May to 24 May:

The sheep feed in early spring on the lower slopes where new growth of grasses and other vegetation is most advanced. On Surprise Mountain they make heavy use of the areas just above alder level from the Skilak Cliffs to Lamb Gulch. Often they bed for the night just above alder level on these south-, east-, southeast-, and southwest-facing slopes. In March the sheep had been using these same general

areas of the mountain (plus the south- and southwest-facing slopes of Russian Mountain), but were feeding much higher on the cliffs where the snow had melted and receded. The lower slopes, which the sheep used in May, were covered with dense, spring snow in March. Geist (1967b:20-21) described a similar pattern of late winter, early spring feeding.

The sheep distribution during this period is also influenced by the use of mineral licks. One lick located low in the cliffs on the southeast corner of the mountain just east of the Skilak Cliffs received heavy use. The sheep would often stop at the lick for several hours and eat soil and rest during movements from one part of the range to another--for example, when enroute from the Russian River Cliffs to the Skilak Cliffs or the reverse. Murie (1944:82) mentioned numerous mineral licks in Mount McKinley National Park. Mineral licks seem to be a characteristic of most Alaska sheep habitats that have been studied.

I made most of these observations of early spring feeding and lick use from a camp located below and just east of the Skilak Cliffs. By 18 May the high meadows on the cliffs above camp were becoming noticeably greener than they had been a week earlier, and the sheep consequently began using them. Often they bedded for the night on these high meadows, in contrast to using bedding sites lower in the cliffs during the previous week. Thus, in the spring of 1967, the greening up of the high meadows seemed to occur just before the onset of lambing.

This pattern of distribution of the sheep at the onset of lambing was fortunate. As the sheep were not using the Skilak Valley side

of Skilak Mountain at all at that time (nor did they begin until 15 June), I was able to tour the top of the Skilak Cliffs without disturbing the sheep. I made four such surveys over the top of the Skilak Cliffs in the pre-lambing period, on 13, 16, 19, and 20 May, but observed no newborn lambs (a newborn lamb is defined as a lamb less than 24 hours old). The sheep were not using the Skilak Cliffs except for the lowest slopes just above alder level.

Lambing area:

All lambing observed in the spring of 1967 was in the Skilak Cliffs. Two newborn lambs were also observed there in the spring of 1968. The only area besides the Skilak Cliffs where lambing activity has been observed on Surprise Mountain is Lamb Gulch (see Fig. 3). This ravine is very rugged and perhaps affords a security similar to the Skilak Cliffs. Will Troyer and Detlef Eisfeld observed three lambs there during the 1966 lambing season. Two were several days old and one just a few hours old and unable to run. Although I made occasional surveys of the Russian River Cliffs and Lamb Gulch during lambing in 1967, on 26 and 27 May and on 4, 6, 16 and 24 June, I saw no lambing activity in this area. In fact, during these surveys I saw no ewes with lambs, indicating that most ewes with lambs prefer to remain near the Skilak Cliffs during the first few weeks of lambing.

One might expect that steep, rugged cliffs with an exposure such that green vegetation is available for the ewe when she resumes feeding would be the preferred lambing areas on all sheep ranges. Dixon (1938:216) noted that "certain south-facing, rugged cliffs in the Savage River Canyon were regularly selected as lambing grounds." He

also noted that such areas are the usual wintering grounds. This may be the usual pattern—that the lambing grounds and the late winter, early spring feeding grounds are in the same general area—since the ecological requirements for them are similar.

The schedule of appearance:

I continued to make frequent surveys over the Skilak Cliffs throughout the rest of May and June to get an idea of the progress of lambing. Figs. 4 and 5 present data from such surveys. I saw the first two lambs of 1967 on 25 May and thought them to be at least several days old, more likely 4 or 5 as they were playing together when first observed at 1105. The 4- or 5-day estimate is based on two negative surveys of the Skilak Cliffs on 19 May and at noon on 20 May. These two lambs may have been the only ones present on this date, since I surveyed the entire Skilak and Russian River Cliffs and saw no others.

As shown in Figs. 4 and 5, the period from 26 May to 6 June was the peak of lambing during 1967. During these 12 days, a minimum of 22-25 lambs were born; I counted 24-27 lambs on 6 June, and two lambs were present before 26 May. This 24-27 figure is surely a minimum number and, as mentioned before, was obtained by surveying the Skilak Cliffs late in the evening when most ewes with young lambs had moved higher on the cliffs than they were during the day. I observed 12 newborn lambs (ca. 50% of those born) and births on 29 and 30 May and 1 June. On 3 days (25% of period), fog prevented survey of the cliffs. On every day that a survey of the cliffs was possible during this period, I observed newborn lambs.

During the next 10-day period, 7-16 June, the pace of lambing

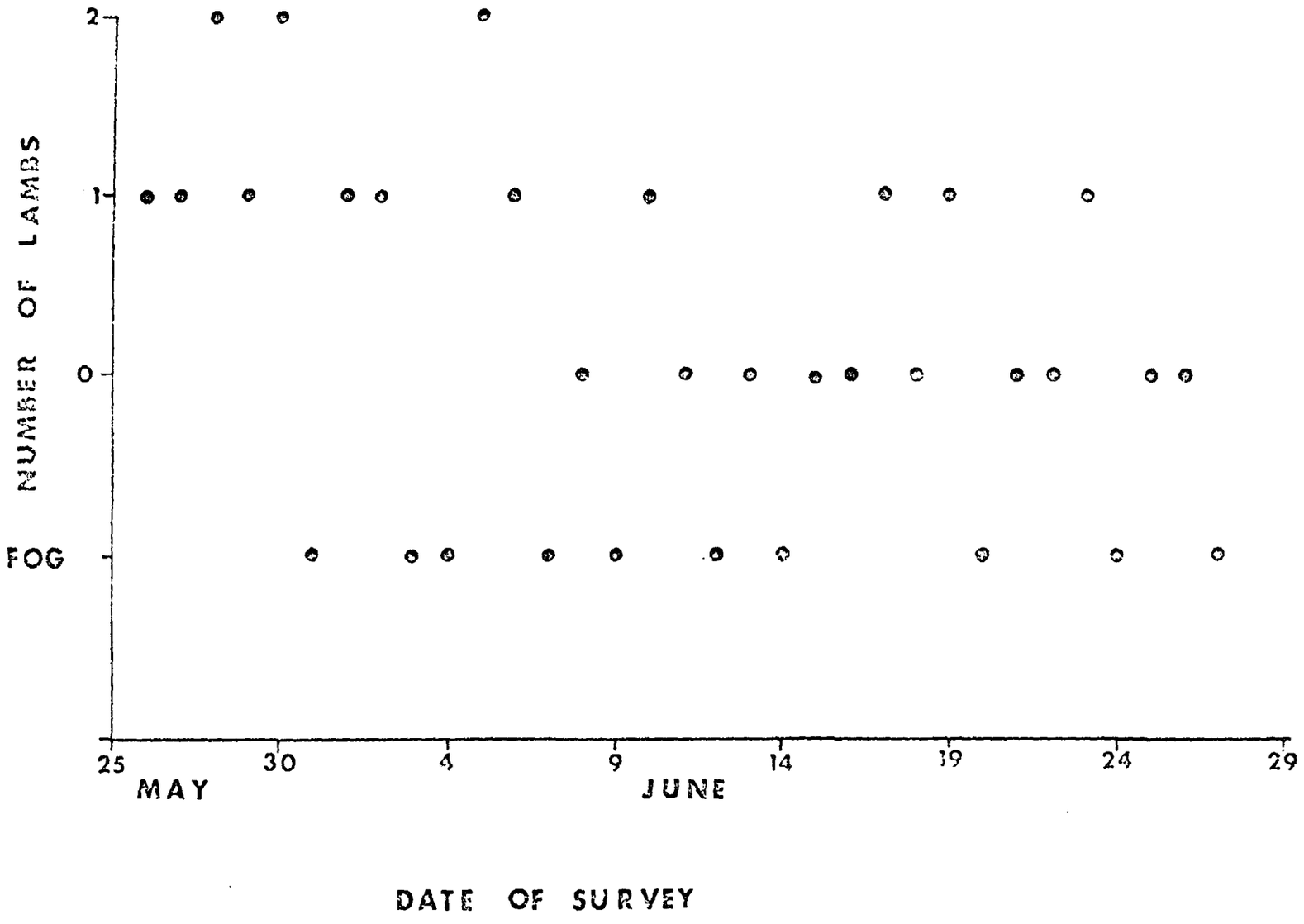


Fig. 4. Number of newborn lambs observed during surveys of Skilak Cliffs: 26 May through 27 June 1967. (Note that a newborn lamb is defined as a lamb less than 24 hours old.)

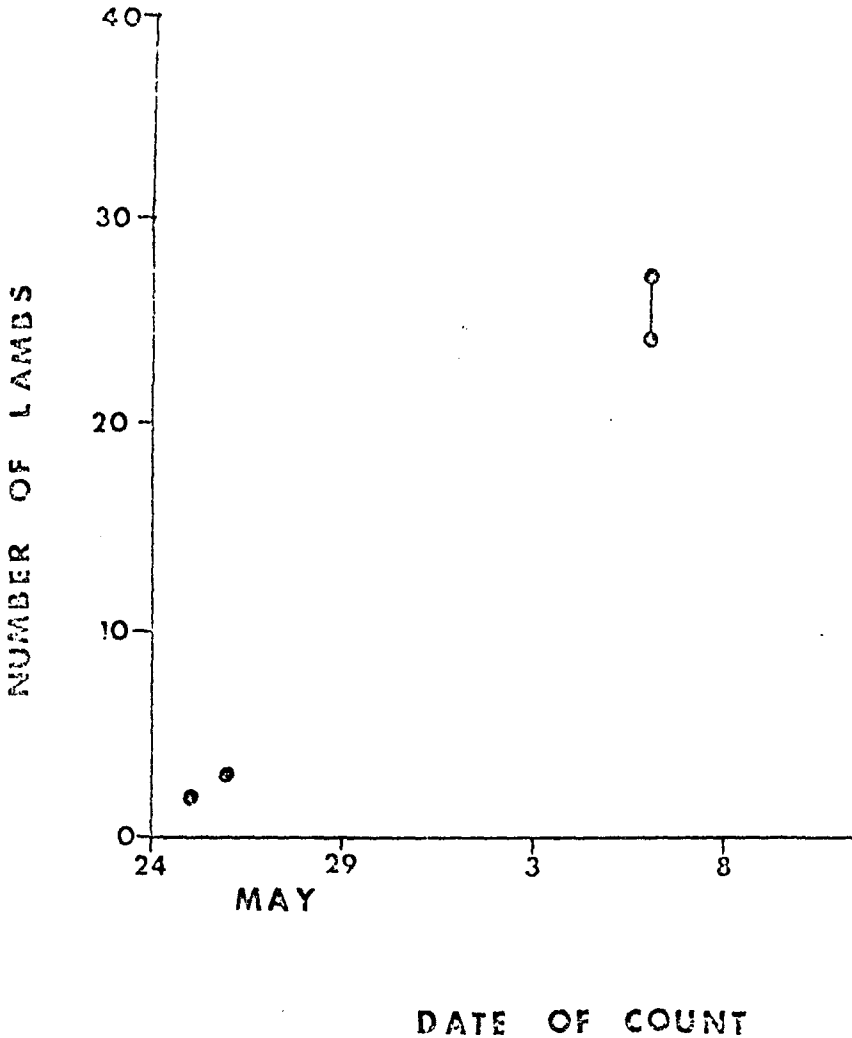


Fig. 5. Results of lamb counts: spring 1967
only ones that were made.)

. (Note that these six counts were the

slowed down. However, fog prevented survey of the cliffs on 4 days (40% of period). On 16 June I counted a minimum of 36 lambs in a very complete census. Therefore, 9-12 lambs may have been born during this period, although this estimate may be high because of lambs missed in the 6 June count. I observed only one newborn lamb. In contrast to the period from 26 May to 6 June, when newborn lambs were observed on every day that a survey was made, on 5 days during the period 7-16 June I surveyed the cliffs but observed no newborn lambs.

During the next 11-day period, 17-27 June, the pace of lambing was also slow. I observed three newborn lambs which appeared to be all that were born during this period, since on 25 June and again on 26 June I counted 39 lambs. I saw a birth on 17 June. Fog prevented survey of the cliffs on 3 days (27% of period), and on 5 days I surveyed the cliffs but saw no newborn lambs.

During the period from 26 May to 27 June I could account for the appearance of 16 newborn lambs. If I add to this figure the first two lambs observed in 1967 and thought born about 20 May, I can account for the birth of 18 of the 39 lambs or about 46% of those born in 1967. Data describing the circumstances of such observations for the 16 newborn lambs are presented in Table 3. Murie's (1944:130) belief that the majority of the lambs are born in the first 2 weeks of lambing was true in 1967, since a minimum of about 65% of the lambs were born then.

TABLE 3. INFORMATION ON 16 NEWBORN LAMBS OBSERVED IN THE SKILAK CLIFFS DURING SPRING OF 1967

Date, time of initial observation	Location	Estimated age of lamb, hr	Comments
5/26, 1013	Below peak, see Fig. 13	5	See Fig. 6.
5/27, 1838	West end of cliffs	5-10	Observed again at 2030.
5/28, 0740	Ridge below peak	8-24	Ewe observed in same spot from 1400 to 2100 on 5/27. Lamb probably born on 5/27, but not visible.
5/28, 1153	East end of cliffs	2-3	See Fig. 7.
5/29, 1546	Below peak, see Fig. 13	0	Birth observed. See Fig. 8.
5/30, 0515	Below peak	0	See Fig. 9.
5/30, 0900	East of peak	8-24	Observed only briefly.
6/1, 2203	Below peak, see Fig. 13	0	Birth observed. See Fig. 10.
6/2, 1024	Below peak see Fig. 13	0-1	Ewe frightened by my presence; observation discontinued. Lamb unable to follow.

TABLE 3. (continued)

Date, time of initial observation	Location	Estimated age of lamb, hr	Comments
6/5, 1256	East of peak	8-24	Observed only briefly.
6/5, 1300	East of peak	8-14	Observed for 1 hour.
6/6, 0937	Below peak, see Fig. 13	1-2	See Fig. 11.
6/10, 2100	Below peak	0-1	Ewe frightened by my presence; observation discontinued. Lamb unable to follow.
6/17, 1840	Below peak, see Fig. 13	0	See Fig. 12.
6/19, 1500	East of peak	8-14	Observed only briefly.
6/23, 1530	West of peak	8-14	Remained in same area for 5 hours.

Discussion

Lamb crops - 1966 versus 1967:

The possibility exists that a large number of old ewes lambed in 1966 and not in 1967 because of the moderately severe conditions existing early in the winter of 1966-67. Ewes in their prime (3-8 yr) may not have been affected by these conditions. Also, many of these old ewes may have been past their reproductive age in 1966, and the lowered natality in 1967 reflects lowered fecundity or fertility among all the ewes because of the poor early-winter range conditions. Talbot and Talbot (1963:70) discussed how a low level of nutrition in many ungulates lowers fecundity, raises prenatal mortality, and results in the birth of weakened young which die soon after parturition. They stressed, in particular, deficiences of vitamin A and protein, but Williams (1962:17-8, 46-47) believed that many nutrients are "...simultaneously necessary for the development of healthy embryos in every mammal." Williams (1962:47) further stressed the importance of adequate nutrition during certain critical periods of development.

> It is interesting that in several instances a deficiency at a particular time during the gestation period may cause abnormalities but later on the same deficiency may be relatively ineffective. This emphasizes the importance of completely adequate nutrition during the stage when organs and structures are first being formed.

If the poor range conditions existing in November 1966 persisted for several months, it is possible that some prenatal loss occurred during these critical periods of embryonic development. Murie (1944:136) related the poor lamb crop of 1940 to the crusted snow conditions

existing in January, and the poor lamb crop of 1932 to the poor range conditions existing in February. In both years lambing was also very late, with the first lambs observed after 1 June.

Neonatal mortality:

The fact that no neonatal mortality was observed during the lambing observations in this study is significant in view of the above discussion of how poor nutrition can affect every phase of the reproductive process from conception to parturition and post-partum vitality. The absence of neonatal mortality suggests that most of the ewes were on a high nutritional plane at parturition and probably before. This might be expected in view of the fact that late winter conditions were very favorable for the sheep. It also suggests that early winter conditions were not severe enough to affect the development of most lambs. Deming (1955:135) described a captive desert bighorn ewe (Ovis canadensis nelsoni) that gave birth to weak lambs 2 years in succession. The condition was corrected by giving her a vitamin supplement. Murie (1944:85) noted that two ewes that were rescued from starvation in April 1929 gave birth at Park Headquarters. One lamb died the second day after birth because the ewe had no milk. Geist (1966:152) provided several references to studies of domestic sheep where low neonatal mortality is correlated with good nutrition.

Other evidence of a healthy population:

Among the characteristics of a high-quality population mentioned by Geist (1966:152) are high reproduction, vigorous lambs, low neonatal mortality, good lamb survival, early maturity, and large body size of lambs, yearlings, and adults. I have presented evidence that

the Surprise Mountain population in 1966 and 1967 satisfied several of these conditions. The fact that the lambs were vigorous is discussed in Part II. There was some evidence that rams on Surprise Mountain may mature early. Geist (1966:46) suggested that it is probable that lip-curling indicates sexual maturity in yearling rams. Lip-curling behavior among yearling rams was frequently observed during the March 1967 field trip, suggesting that many were sexually mature by 21 months, at the latest. The yearling rams on Surprise Mountain were also large; they had body and horn size comparable to ewes by late summer. The adult rams were large (field weight of a 5-year-old was 190 lb., calculated by multiplying weight of carcass by 1.08 for blood loss as suggested by Geist: 1966) and had rapid horn growth, as evidenced by the fact that most reached legal size (three-quarter curl) by age 4.

This information on population quality, in general, and on the condition of the ewes before parturition in 1967, in particular, provides a perspective for viewing the observations on birth behavior in Part II. Perhaps it also suggests what the general pattern of these observations will be in terms of maternal responsiveness and neonatal vitality in the first critical hours after birth.

PART II

BIRTH BEHAVIOR AND ACTIVITY OF EWE AND LAMB DURING THE FIRST DAY AFTER PARTURITION, WITH A FEW NOTES ON LATER BEHAVIOR

Activity charts

The following discussion of birth behavior is based on the continuous observation for extended periods of seven neonates during the day of their birth. Activity charts for the ewes and lambs of 5/26, 5/28, 5/29, 5/30, 6/1, 6/6, and 6/17 are presented in Figs. 6-12. In these charts, as elsewhere in this thesis, an active animal is one that is standing up; a resting animal is one that is lying down. The one exception to this definition is a newborn lamb less than 1 hour old that may not have fully attained the ability to stand. In this circumstance, the lamb crawling or struggling to get to its feet is considered active.

SYMBOLS USED IN FIGURES 6-12

center line - continuity of observation

upper line - lamb active

lower line - ewe active

* - beginning or end of activity period not observed

Numerical data:

figures above nursing observations denote duration of nursing event in min (to nearest 10th)

figures in parentheses denote distance (yd) that ewe or lamb might move in the course of certain activities

Activity of ewe	Activity of lamb
A - smells or licks anal area of lamb	c - contactual behavior, usually touching noses
B - paws at birth bed	e - walks to ewe
C - contactual behavior, usually licking	f - falls
E - eats placenta	k - walks on front knees
F - feeds	l - walks on all four legs
L - walks to lamb	n - nurses
P - paws lamb	p - neonatal play
R - paws lamb repeatedly	s - struggles to get to feet
S - paws lamb several times	u - under udder, apparently searching for nipple

broken line following activity symbol - duration of particular activity

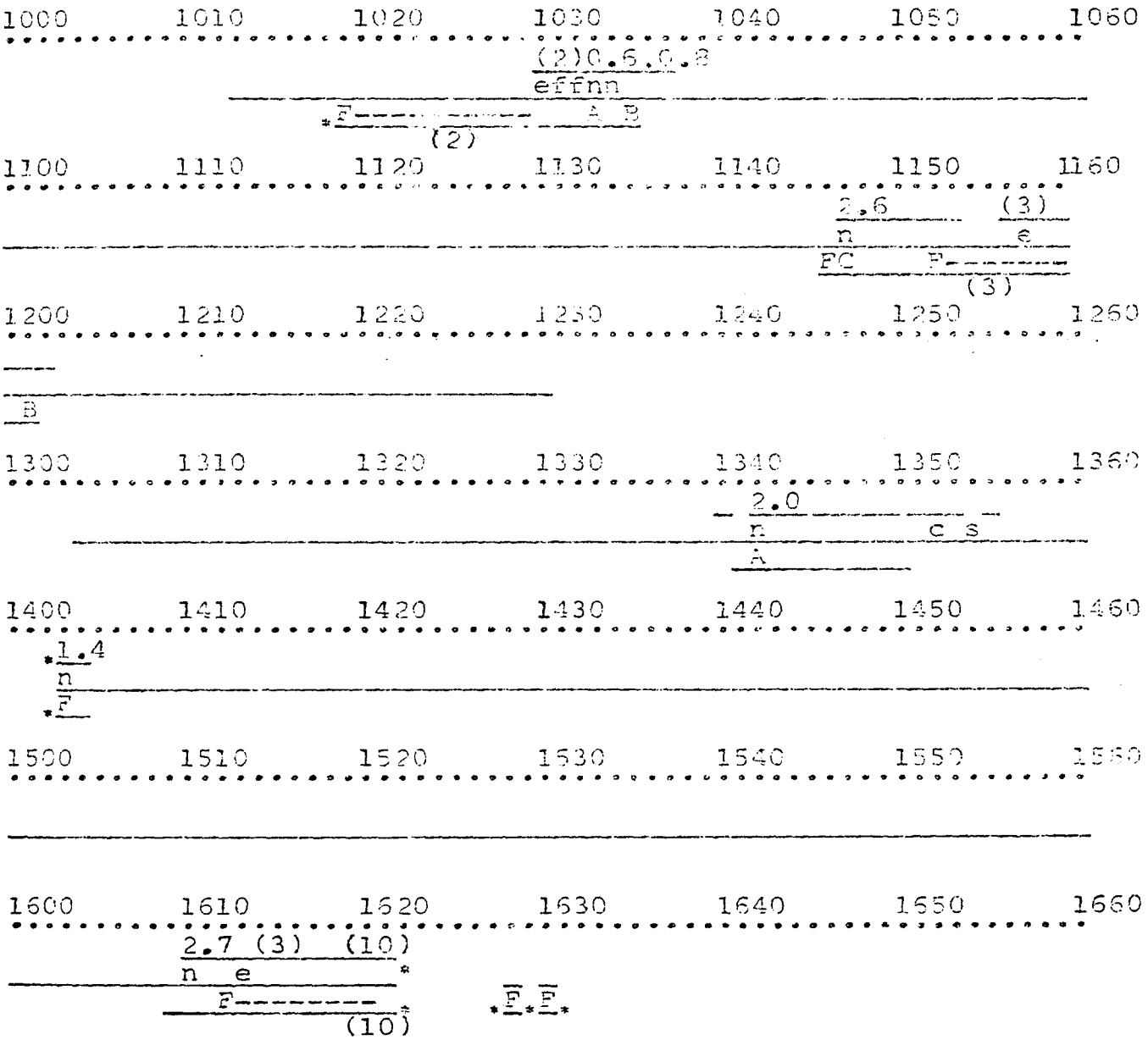


Fig. 6. Activity chart of the first day after birth for ewe and lamb of 5/26.

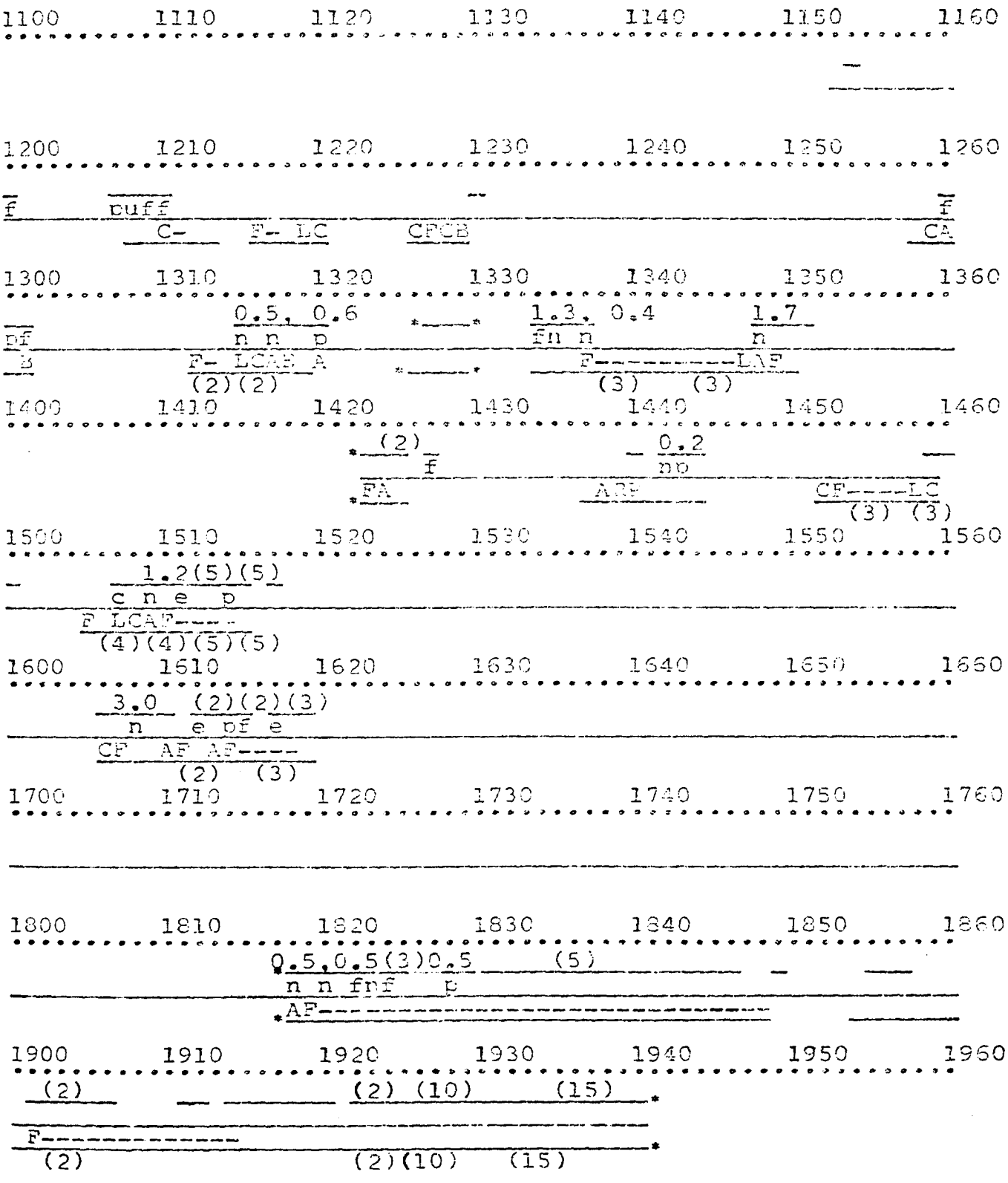


Fig. 7. Activity chart of the first day after birth for ewe and lamb of 5/28. (Note that at 1326 a golden eagle swooped low over ewe and lamb, as described in Part I. At 1437 the ewe jumped at a magpie, as described in Part I.)

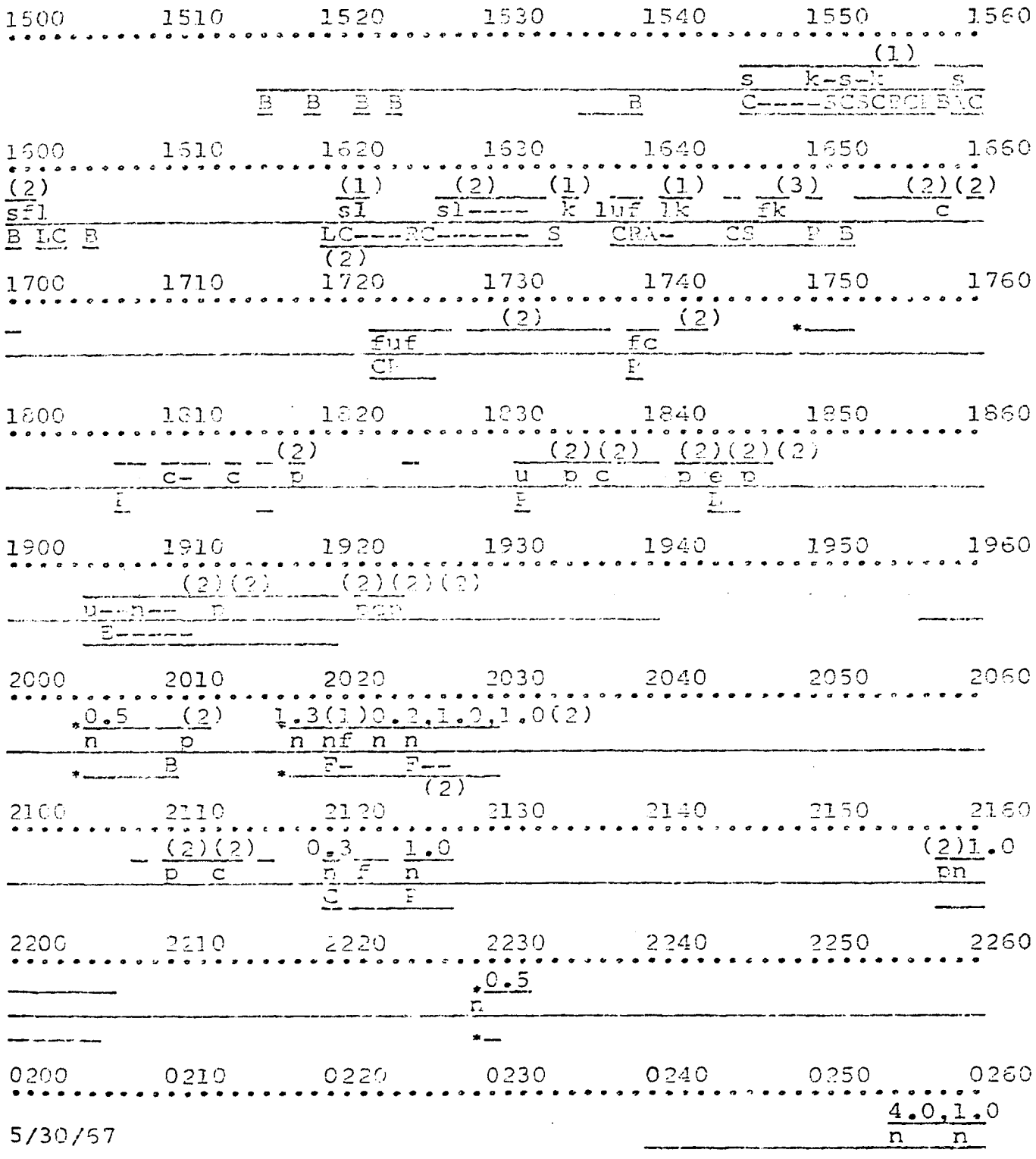


Fig. 8. Activity chart of the first day after birth for ewe and lamb of 5/29.

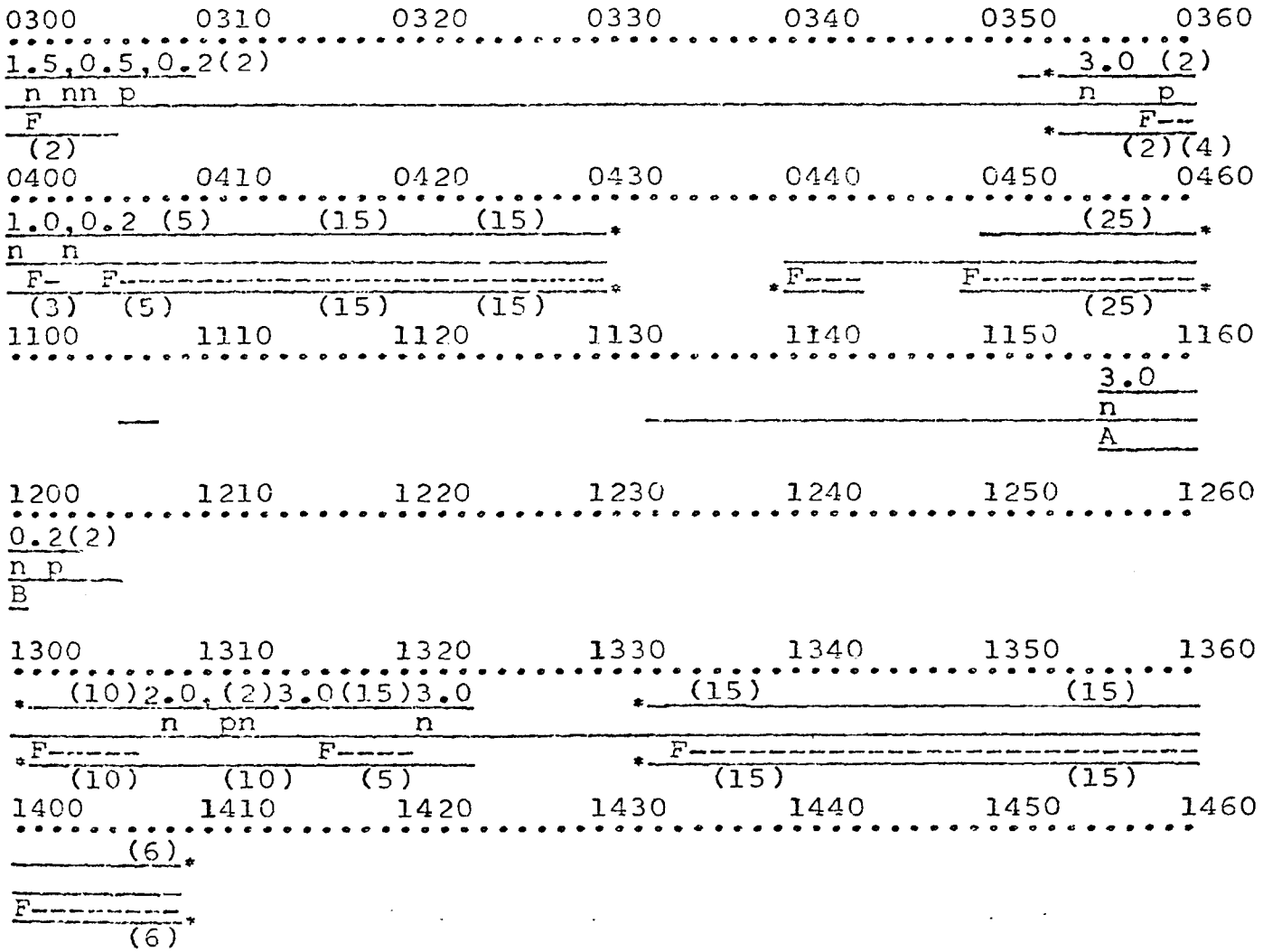


Fig. 8. (continued)

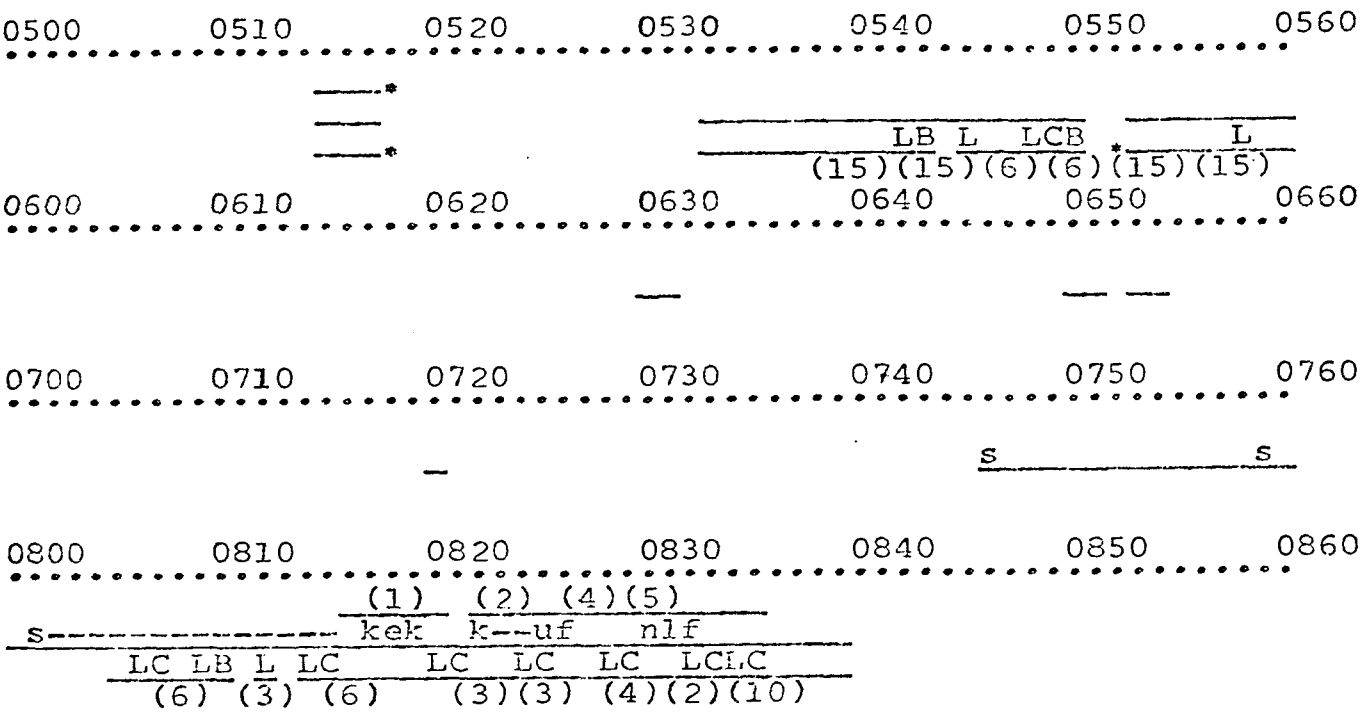


Fig. 9. Activity chart of the first day after birth for ewe and lamb of 5/30. (Note that at 0832, after following the ewe for about 10 yd on the snowbank, the lamb fell and began to roll down the snowbank. The ewe ran to the lamb and tried to stop the fall but was unsuccessful, and the lamb continued to the bottom of the snowbank—ca. 10 yd. The ewe ran down to the lamb and tried to encourage it to follow, but the lamb was unable. Observation discontinued; when I returned several hours later ewe and lamb were not present.)

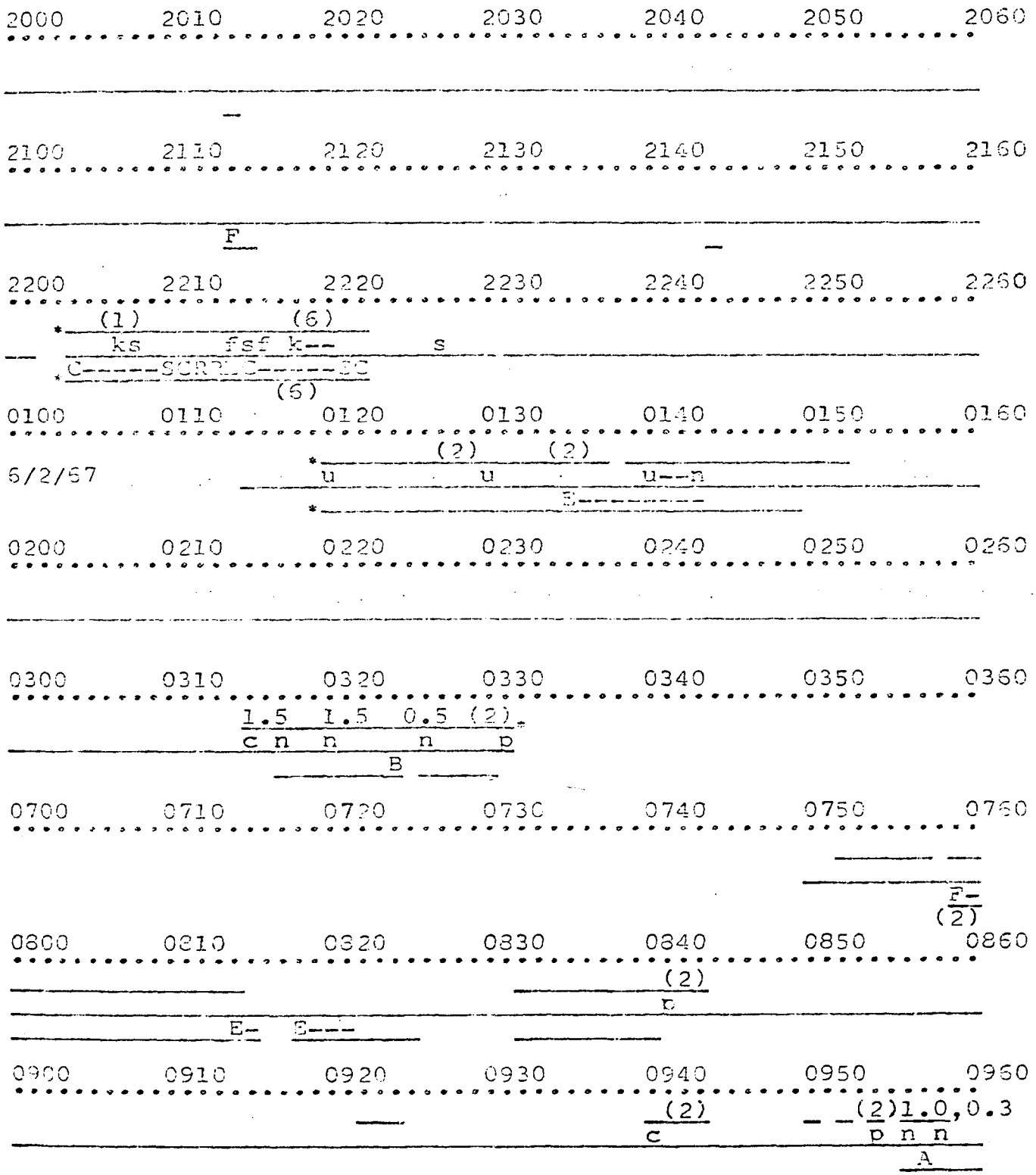


Fig. 10. Activity chart of the first day after birth for ewe and lamb of 6/1. (Note that from 0332 to 0749 on 2 June the ewe and lamb were kept under continuous observation, but the record was lost as the tape recorder failed to operate in the freezing temperatures.)

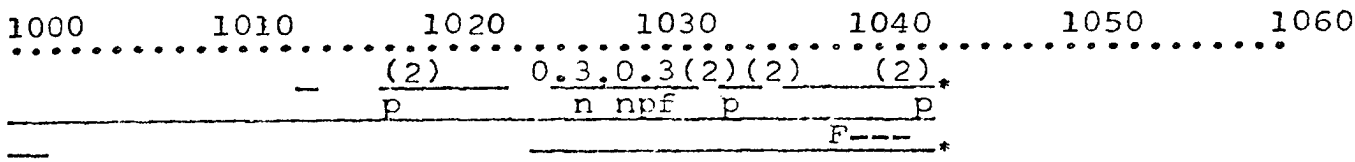


Fig. 10. (continued)

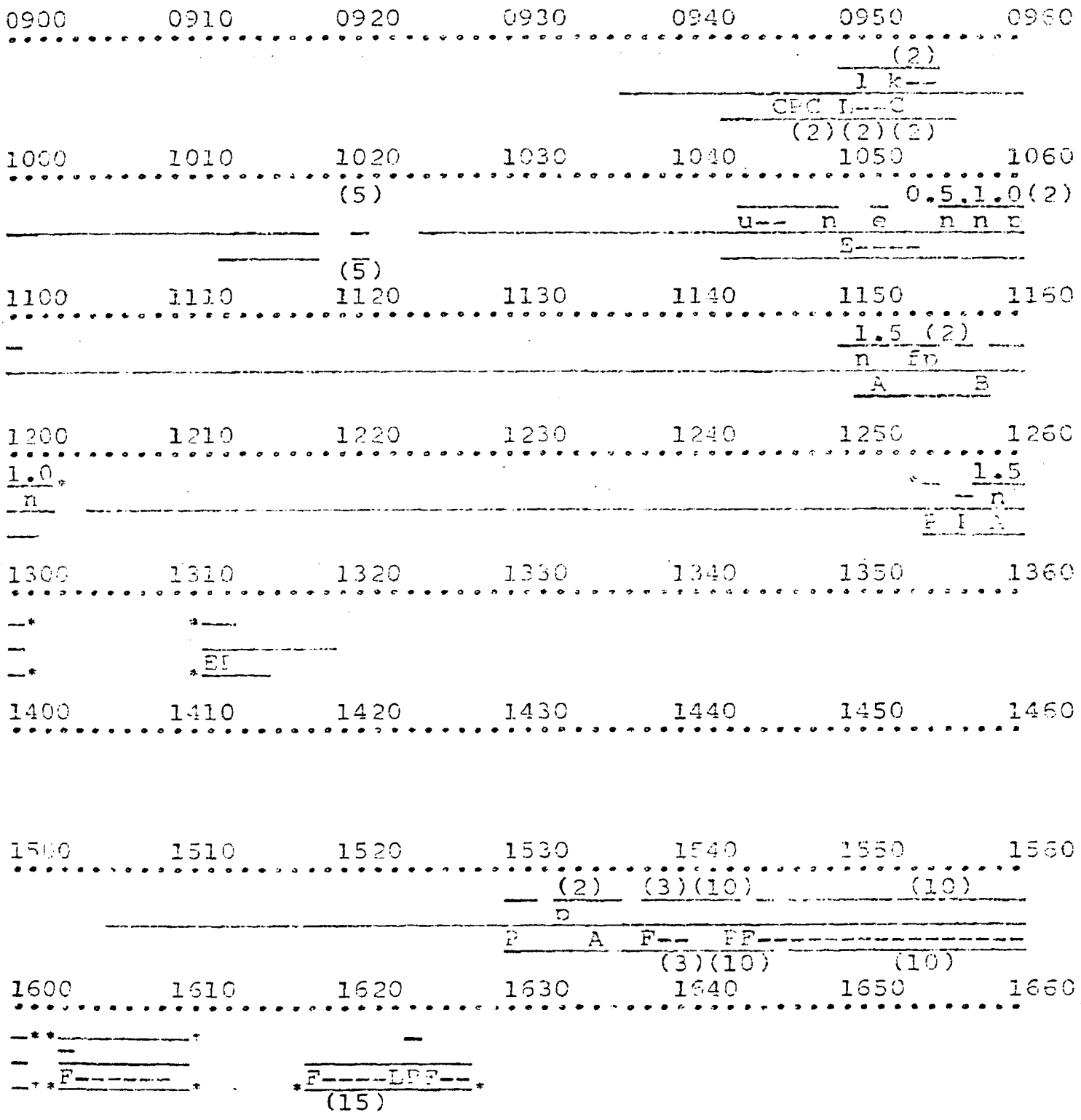


Fig. 11. Activity chart of the first day after birth for the ewe and lamb of 6/6.

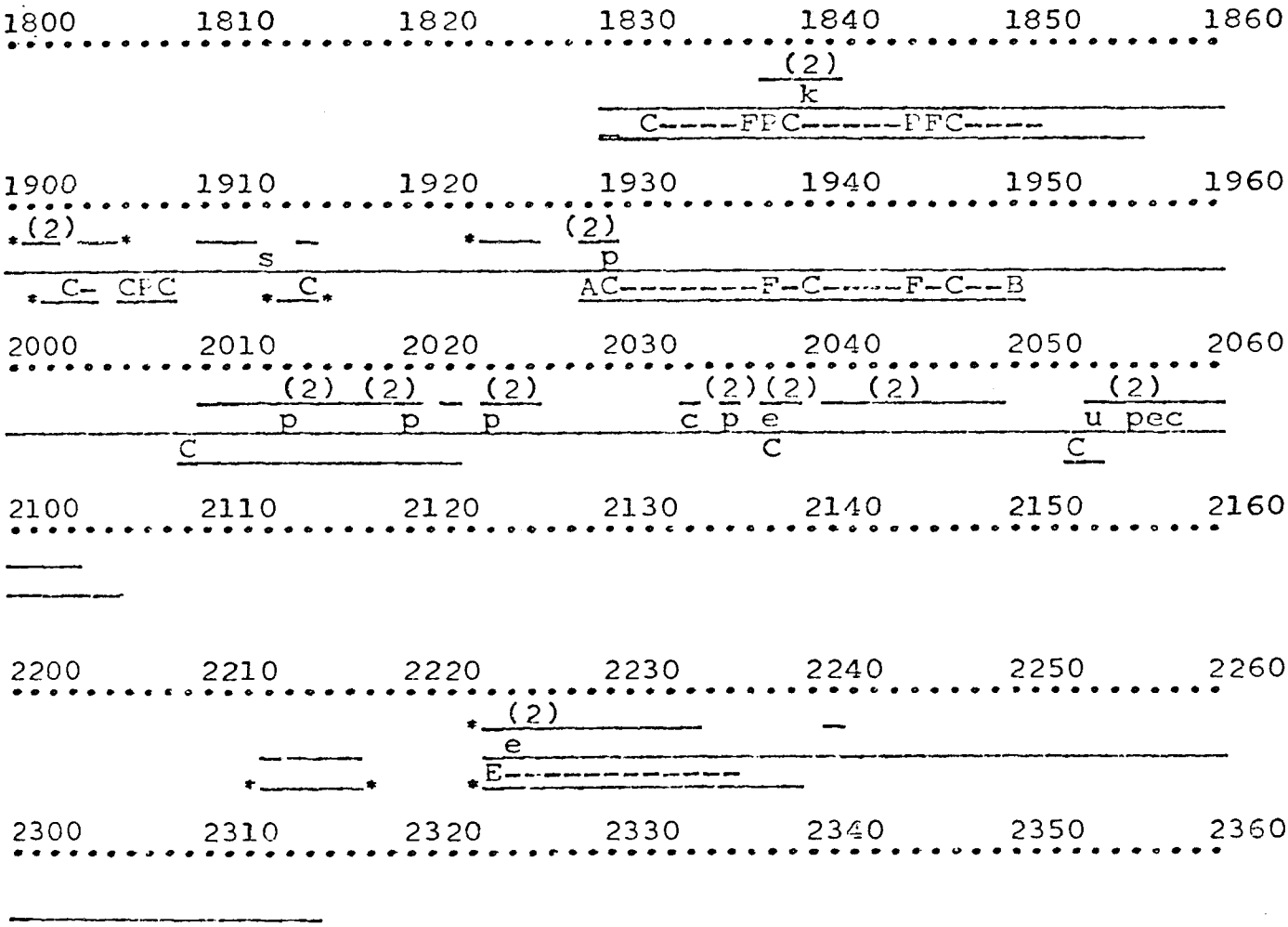


Fig. 12. Activity chart of the first day after birth for ewe and lamb of 6/17.

Prenatal care

Maternal isolation:

Parturient ewes seek the security of high cliffs as much as 12 hours before the birth of their lambs. Of the 16 observations of newborn lambs in 1967, all but three or four were apparently born very high in the Skilak Cliffs. Six of them were apparently born in an area of about 30 square yards just below the Skilak Peak (see Fig. 13). By seeking out such areas high in the Skilak Cliffs, the ewe achieves what I have termed maternal isolation, since such areas are not often visited by the rest of the sheep during the lambing season. Most of the lambless ewes, yearlings, and rams prefer to feed elsewhere than among the rocky escarpments high in the cliffs. They often feed very low in the cliffs, just above alder level, and on the more meadow-like slopes to the east and west of the cliffs, or in the cliffs above the Russian River. Even ewes with lambs just a few days or weeks old spend most of their time lower in the cliffs. They often feed very low on the cliffs, or on the slopes to the east and west, often returning to the cliffs or higher on the cliffs for rests during the day or at night. It appears that the parturient ewe, feeling restless as birth approaches, seeks out an area which offers the utmost protection from disturbance either by other sheep or predators, and this is where she will lamb.

The maximum time that a ewe was observed in the isolation of the birth area before parturition was about 12 hours. The ewe of 6/6 was resting fitfully on the birth bed (see Fig. 13) at 1900 on 5 June; the estimated time of birth for her lamb was between 0800 and

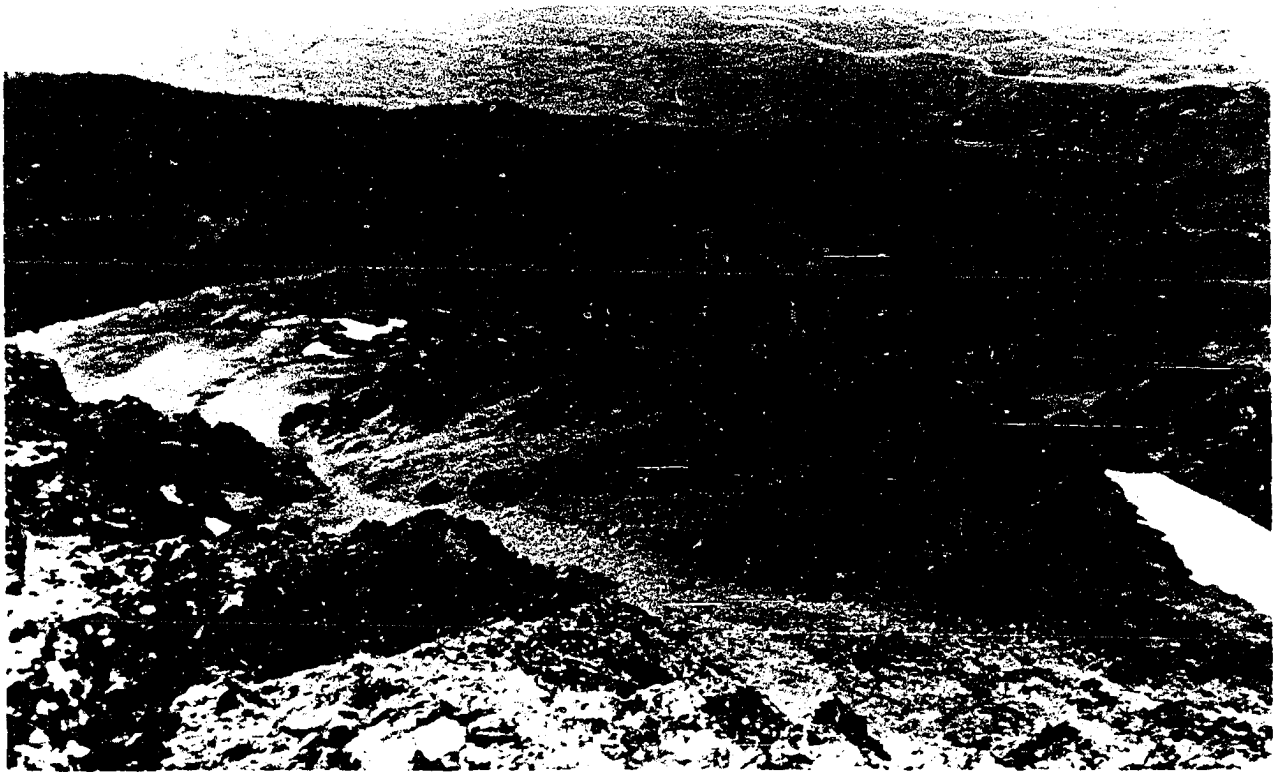


Fig. 13. Area below the Skilak Peak where many lambs were born. Numbers on picture are immediately below the following sites referred to in text: 1) Location of birth bed of ewe of 5/29. 2) Location of birth beds of ewes of 6/1 and 6/17. These ewes lambed in the same area, perhaps in the same bed. 3) Location of birth bed of ewe of 6/6. 4) Place where ewe and lamb of 5/26 were first observed. At noon on 26 May, this ewe and lamb walked down and rested at 1; they rested here between activity periods for the rest of the afternoon. 5) Place where ewe and lamb of 6/2 were first observed. Many (8) other ewes with newborn lambs were first observed in this same general area, perhaps 40 yd east or west.

0900. The ewe of 5/30 was also thought to have sought isolation about 12 hours before parturition. She showed a marked interest in the newborn lamb of another ewe at this time, a behavior often noticed in parturient domestic sheep (Hersher et al., 1963:206; Thorpe, 1963:448). I was recording at the time the activity of the lamb of 5/29. The ewe of 5/30 climbed up in the ravine at 1638 to the birth place of the lamb of 5/29 (see Fig. 13) and smelled the lamb and soil of the birth bed, and then proceeded 15 yards higher in the ravine and rested. However, there was no way I could continue observation of the lamb of 5/29 and remain out of view of the ewe of 5/30. She soon spotted me and began staring at me, and at 1727 stood up and proceeded down the ravine; in passing the lamb of 5/29, she again stopped and smelled the lamb and its birth area. Her udder also appeared distended, and she walked awkwardly. This ewe apparently had to settle for a less-preferred lambing spot halfway down the ravine because of my presence, a spot which turned out to be a very poor choice, as explained later. Her lamb was born about 0500 on 30 May. I saw several other ewes in parturient isolation several hours before the birth of their lambs: the ewe of 6/17 4 hours before parturition and the ewe of 6/1 2.5 hours before parturition. Smith (1965) reported that domestic sheep withdraw from the flock for a similar period, sometimes as long as a day or more.

Restless behavior of ewe:

Among domestic sheep and goats and most ungulates, the first sign of approaching parturition is a general restlessness. Hersher et al. (1963:206) described the restless behavior of domestic sheep and goats and this seems applicable to wild sheep, also.

> The dam rises and moves about fitfully, lies down again, chews her cud, nibbles hay, gasps, blows through her nostrils, paws the ground, grunts, often pawing out a hollow in the straw and lying in it.

The first ewe I saw in this condition was the ewe of 5/29, first seen at 1515. In the next 5 minutes she got up from resting, pawed at the bed, and then rebedded 5 times. There was no question about what was in progress. The ewe lambed half an hour later at 1556. The ewes of 6/1 and 6/17 were also very restless when first observed 2.5 and 4 hours before parturition.

The birth bed:

All resting in these hours before birth is done in the same bed. The ewe might get up and feed for short periods, then return to the bed. A common pattern is to get up, paw at the bed for up to 30 seconds, perhaps turn around, and then rebed again in the same place. In the process of such activities the ewe creates a depression in the ground which I have called the birth bed.

All ewes observed in the period before parturition oriented their activities around a birth bed. Thus, the data for the length of maternal isolation indicate the time spent in the birth bed before parturition, except for the ewe of 5/30. The birth bed usually remains the focus of activity for the ewe and lamb for 8-12 hours after birth, and the ewe and lamb may return to rest in the birth bed up to 24 hours after birth. Several ewes rested in the birth beds of other ewes: the ewe and lamb of 6/5 in the birth bed of the ewe of 5/29 at 1505 and following, and the ewe and lamb of 6/10 in the birth bed of the ewe of 6/6 for much of the afternoon of 11 June. These observations may relate only to the limited number of level areas

suitable for bedding in such places (see Fig. 13).

Smith (1965:84) described a similar tendency for domestic sheep to relate to a birth bed long before the birth of the lamb and suggested that perhaps they are attracted to the birth fluids which might be passed several hours or longer before birth.

> The ewe...becomes noticeably more restless, alternatively rising to its feet and lying down and walking about within a confined area. The walking is interrupted by repeated sniffing of the ground which may precede but usually follows the first discernable flow of fluid from the vagina. This sniffing of the ground frequently has the appearance of searching. Unless disturbed, it is rare for the ewe to leave this area which she has 'searched' in this way, until some time after the birth of the lamb. The water 'bleb' usually protrudes from the vagina during this stage.

I did not observe such sniffing of the ground by the parturient ewes in this study in the hours before birth, although I may have interpreted such behavior as feeding. Simmons et al. (1963) described a "shallow basin scraped in the soil" in their description of the birth site of a desert bighorn ewe.

The birth process:

The best documented birth was the lamb of 5/29. The lamb was beginning to emerge at 1536 when the ewe stood up, pawed the bed, and rebedded. The ewe was panting heavily, opening her mouth and lurching her head forward every 2 seconds during the contractions. A minute later she stood up again, and I could see the feet of the lamb. The ewe turned around, pawed the bed, and rebedded at 1540. As she rested in the bed, her belly raised several inches off the ground as she panted during the contractions. I could see the entire head and most of the neck of the lamb. By 1545 the forelegs were out, and the lamb began coming very fast and shook its head. Then the ewe

stood up, and the lamb fell to the ground. Thus, in this birth, it was only about 10 minutes from the first appearance of the lamb to the final expulsion. Although the ewe was first observed 30 minutes before the birth, heavy panting during contractions was first noticed 10 minutes before parturition. I estimated this ewe to be about 5 or 6 years old from the growth rings I could see on the horns at 40 yards distance. Therefore, she had probably lambed before.

The only other birth in which I saw the process of emergence was that of 6/1. Although I did not see the emergence of the lamb itself, it was preceded by the appearance of birth membranes. At 2115 membranes were beginning to emerge. By 2121 the ewe was beginning to pant heavily during contractions that were coming at intervals of several minutes. Eleven minutes later the contractions (as evidenced by the panting) appeared to be coming more frequently (ca. a 20-second interval between 20-second contractions). At 2144 the ewe rose again, and a much larger quantity of membranes had emerged. She rested again at 2145. The ewe remained resting until 2202 when I looked away. At 2204 I looked back, and the ewe was standing up licking the lamb. The lamb appears to have emerged entirely during the last 15 minutes while the ewe was resting. But in this birth, membranes appeared about 48 minutes before the final expulsion of the lamb. Heavy panting during contractions was first observed 42 minutes before the birth. I estimated this ewe to be 3 or 4 years old from a similar distance to the ewe of 5/29. Therefore, she may have been primiparous.

Dixon (1938) noted that the process of emergence took only 15 minutes in a lambing observation in Mount McKinley National Park on 28 June 1932 by F. W. Morand.

Postpartum activity

Birth to the establishment of stable activity periods - birth to approximately 3.5 hours after birth:

First activity of ewe and lamb following birth:

As mentioned before, the lamb of 5/29 was shaking its head before it was entirely out of the ewe. This lamb was active immediately after birth, shaking its head and crawling about with jerky movements. The lamb of 6/1 was similarly active in the first minutes after birth. These were the only lambs visible immediately after birth.

As is characteristic of most ungulates, the ewe's first activity after birth is to lick the lamb for the first minute or two after birth. The ewe of 5/29 turned around immediately and licked the face and head of the lamb. Licking progressed back over the rest of the body during the next 6 minutes in the pattern of shoulder, hind legs, back, head, hind legs, back, neck, and head. This corresponds closely with the pattern described by Hersher et al. (1963:207) for domestic sheep.

> The mother begins licking the neonate almost immediately after delivery. Most frequently she starts with the head, working gradually over the body until the newborn animal is completely dry and free of birth membranes.

The ewe of 6/1 was licking her lamb during the period immediately after birth, although the actual bodily distribution of the licking was not discernable in the failing light. Both ewes may have eaten the amnion during the period immediately after birth, but I was not able to distinguish this act from the general licking. Nor was I able to hear any vocalizations between the ewe and lamb, such as is

often noted in domestic sheep (Smith, 1965:84), although such sounds may not travel far enough to be heard by a distant (40-100 yd) observer.

Both lambs were very active during the maternal licking in the 8-10 minutes after birth. They shook their heads almost constantly and struggled to get to their feet but only managed a jerky crawl in the first minute after birth. The lamb of 5/29 had almost gotten to its feet 1 minute after birth. By 1551 (00:05 = time after birth in hours and minutes. Figures in parentheses will denote time after birth.), this lamb was walking on its hind legs and front knees. This pattern of the hind legs coordinating sooner than the forelegs was also observed among lambs 5/30, 6/1, 6/6, and 6/17.

During these first few minutes of life the lamb's coat becomes soiled from crawling and falling in the dirt while still wet with birth fluids and may retain this brownish stain for several days. I noticed that the first two lambs observed on 25 May were markedly browner than their mothers and thought them to be 4-5 days old.

Postpartum pawing of lamb:

Although the lambs of 5/29 and 6/1 were in a constant struggle to get to their feet in the first few minutes after birth, the ewes in this study appeared to have an instinctive response to paw them with their forefeet. Perhaps the ewes feel aggressive toward their lambs that are crawling about with spasmotic, jerky movements. Geist (1966:12) noted that pawing is often used to encourage a conspecific to vacate a bed or salt block; thus, pawing does occur in "normal" aggressive behavior.

The ewe of 5/29 first pawed her lamb at 1552 (00:06); the lamb

responded with vigorous kicking of its hind legs. For the next 4 minutes, until 1556, the ewe frequently interrupted her continuous licking of the lamb to paw it. The lamb frantically kicked its hind legs when pawed and appeared to be trying to crawl away from the ewe, as it moved several feet above the birth bed. The lamb of 6/1 was very active in the first 5 minutes after birth and crawled a foot or two to a corner of the birth bed. As did the ewe of 5/29, the ewe of 6/1 first pawed her lamb about 6 minutes after birth. And, as for the ewe of 5/29, the period 8-10 minutes after birth seemed to be the peak of this postpartum pawing for the ewe of 6/1. Both lambs reacted to this pawing with vigorous crawling and moved above the birth bed. Having crawled several feet above the bed during the heavy pawing of 1554-1556, the lamb of 5/29 rested for the next few minutes. After several minutes of licking the lamb, the ewe returned to the birth bed and rebedded at 1600. A minute later the lamb, when struggling to get to its feet, fell down into the birth bed but immediately went back above the bed and crawled into a crevice between two rocks and rested. This lamb appeared to prefer to rest away from its mother for the moment. The ewe went up to the lamb and licked it again for several minutes and at 1604 returned to rest in the birth bed.

Falling is a frequent occurrence during this postpartum pawing. The lamb of 6/1 had crawled several feet above the bed during the heavy pawing 8-10 minutes after birth. However, during the repeated pawing at 2213 (00:10), it fell and rolled down a scree slide and stopped several feet below the birth bed. In attempting to get up at 2215, it fell several more feet below the birth bed; the ewe

followed it down and licked it. During the next 5 minutes, the lamb crawled and walked on its front knees all the way back up to the birth bed. The ewe remained with the lamb, often licking it, as if to encourage the lamb to return to the birth bed, where they both rested at 2221 (00:18).

There is indirect evidence of this same pattern, the lamb falling below the bed during the postpartum pawing, and the ewe following it down and encouraging it to return to the birth bed, in three other births: those of 6/17, 6/6, and 5/30. The ewe of 6/17 was first observed with her new lamb at 1840 (00:10). They were 6-8 feet below the birth bed and most of the time out of view behind a rock ledge. The ewe had been down below the birth bed with the lamb since 1830. At 1856 the ewe rebedded in the birth bed, and the lamb was still out of view below the bed. At 1901 the lamb crawled up to the birth bed. It took the lamb about 30 minutes to crawl back up to the bed.

I first saw the ewe and lamb of 6/6 at 0937 about 6-8 feet below the bed in which the ewe had been resting at 1900 on 5 June. At 0943 the ewe stood up; several minutes later she licked and pawed the lamb. The lamb did not respond; the ewe returned to the birth bed, then at 0948 went back down to the lamb and licked it. Again, the lamb did not respond; at 0950 the ewe returned to the birth bed, rebedded for 5 seconds, and then went back down to the lamb and licked it. The ewe again returned to the birth bed; the lamb followed, walking on its front knees, and joined the ewe in the birth bed at 0956. Within 10 minutes the ewe had made four trips up to the birth bed for a short rest, then immediately back down to lick the lamb, as if to

encourage it to crawl up to the birth bed and rest there.

The ewe of 5/30 lambed about 0515, but neither the ewe nor the lamb were visible for the next 18 minutes. When next observed at 0533 the lamb was caught in a crevice at the edge of a snowbank about 8-10 feet below the birth bed, and it was unable to get free. For the next 3 hours the lamb remained in this predicament. The ewe rested in the birth bed, but made frequent trips down to the lamb. I saw at least 12 such trips down to the lamb in the intermittent lifts of the fog. This ewe was apparently aware of my presence, and, as discussed earlier, the very location of the birth bed was a result of this. Soon after the lamb was caught in the crevice, the ewe walked 15-20 yards east of the lamb, as if about to leave the area. She was probably still aware of me and therefore very confused, as her lamb was in no position to follow. At 0553 she again wandered 15 yards east. Several hours later, at 0820, when the lamb was finally able to free itself, the ewe immediately tried to encourage the lamb to leave the area. She may have left because of my presence to seek a more secure site. She encouraged her lamb to follow in the same way the ewe of 6/6 encouraged her lamb to return to the birth bed. She would walk a few yards west, then return to lick the lamb, then farther west again. She did this 7 times in the 10 minutes following 0820 and was able to encourage the lamb to follow her for about 10 yards. The ewe of 6/2 was also frightened by my presence, and tried to get her newborn lamb to follow her from the area with a similar pattern of encouragement. The lamb, seemingly born within the hour, followed about 10 yards and then laid down, unable to go farther. Lent (1966:729) described a similar pattern of encouragement by

caribou cows.

Most ewes and lambs rest for a short time after the postpartum pawing. The ewe of 5/29 rebedded in the birth bed, while the lamb apparently rested several yards above the bed for 18 minutes (although it was out of view during this time). At 1620 (00:34) the ewe went up to the lamb and licked it, and in the next 15 minutes encouraged the lamb to join her in the birth bed. The lamb of 6/1 rested after climbing back up to the birth bed, having fallen below during the postpartum pawing. It rested just above the ewe in the birth bed and was still resting at 2300 (00:57) when observation was discontinued. The lamb of 6/17 may have rested while crawling back up to the birth bed after the fall, since the lamb was not visible below the bed for 30 minutes before it joined the ewe in the birth bed.

Generalized activity:

If it is critical that regular nursing begins as soon after birth as possible, one might expect that the ewe would possess instincts to ensure that the lamb maintains a high level of activity during the period before such nursing begins. The activity pattern for the lamb of 5/29, the only one for which a complete record is available for this period, is consistent with this assumption. Per cent activity for half-hour observation periods from birth to the start of regular nursing is given in Table 4 for the lamb of 5/29. The mean of these seven periods is 44%, the range 37% to 57%, and the standard deviation only 6%.

Similar data in Tables 5 and 6 for the other two lambs of known time of birth seem to indicate a high level of activity in the period

TABLE 4. PER CENT ACTIVITY FOR HALF-HOUR OBSERVATION PERIODS FROM BIRTH TO 3.5 HOURS AFTER BIRTH FOR LAMB OF 5/29

Time	Age of lamb, hr	Per cent activity
1546 - 1616	0.0 - 0.5	45
1616 - 1646	0.5 - 1.0	42
1646 - 1716	1.0 - 1.5	42
1716 - 1746	1.5 - 2.0	57
1746 - 1816	2.0 - 2.5	37
1816 - 1846	2.5 - 3.0	45
1846 - 1916	3.0 - 3.5	40

TABLE 5. PER CENT ACTIVITY FOR HALF-HOUR OBSERVATION PERIODS FROM BIRTH TO 4.0 HOURS AFTER BIRTH FOR LAMB OF 6/1

Time	Age of lamb, hr	Per cent activity
2200 - 2230	0.0 - 0.5	69
2230 - 2300	0.5 - 1.0	0
0100 - 0130	3.0 - 3.5	67
0130 - 0200	3.5 - 4.0	73

TABLE 6. PER CENT ACTIVITY FOR HALF-HOUR OBSERVATION PERIODS FROM BIRTH TO 2.5 HOURS AFTER BIRTH FOR LAMB OF 6/17

Time	Age of lamb, hr	Per cent activity
1900 - 1930	0.5 - 1.0	35
1930 - 2000	1.0 - 1.5	3
2000 - 2030	1.5 - 2.0	50
2030 - 2100	2.0 - 2.5	60

from birth to the start of regular nursing. The regular nursing pattern for the lamb of 6/1 began at 0137 (03:34) on 2 June. The lamb of 6/17 had not begun regular nursing by 2104 (02:34) when observation was discontinued for 1.25 hours. A complete record of the per cent activity data for the lambs of 5/26, 5/28, 5/29, 6/1, 6/6, and 6/17 is given in Figs. 14-19. Data are given for the entire duration of observation for each lamb. However, only those half-hour observation periods with a minimum of 15 minutes of observation are considered.

The activity periods of newborn lambs are punctuated by frequent short rests lasting from a few seconds to several minutes. In order to simplify the behavior profile of the lamb and see it in larger units of activity and rest, I have considered a somewhat unusual definition of activity and rest. For such purposes an activity period can encompass rest periods of up to 5 minutes in length. Any activity of the lamb, no matter how short, that comes within 5 minutes of a previous activity period of greater than 1 minute becomes a part of that activity period. A rest period can encompass small activity periods of 1 minute or less. Of course, it would be possible for a lamb to consistently get up for a very short activity period after a 4-minute rest, thereby giving distorted data, but the lambs of 1967 did not do this often. The advantage of this definition is that it shows the chronology of activity and rest that is not so clear in the per cent activity graphs. Activity and rest periods for the lamb of 5/29 from birth to 1923 (03:37) or, roughly, birth to the start of the regular nursing pattern are given in Table 7.

When viewed from this definition, the period from 1620 (00:34) to

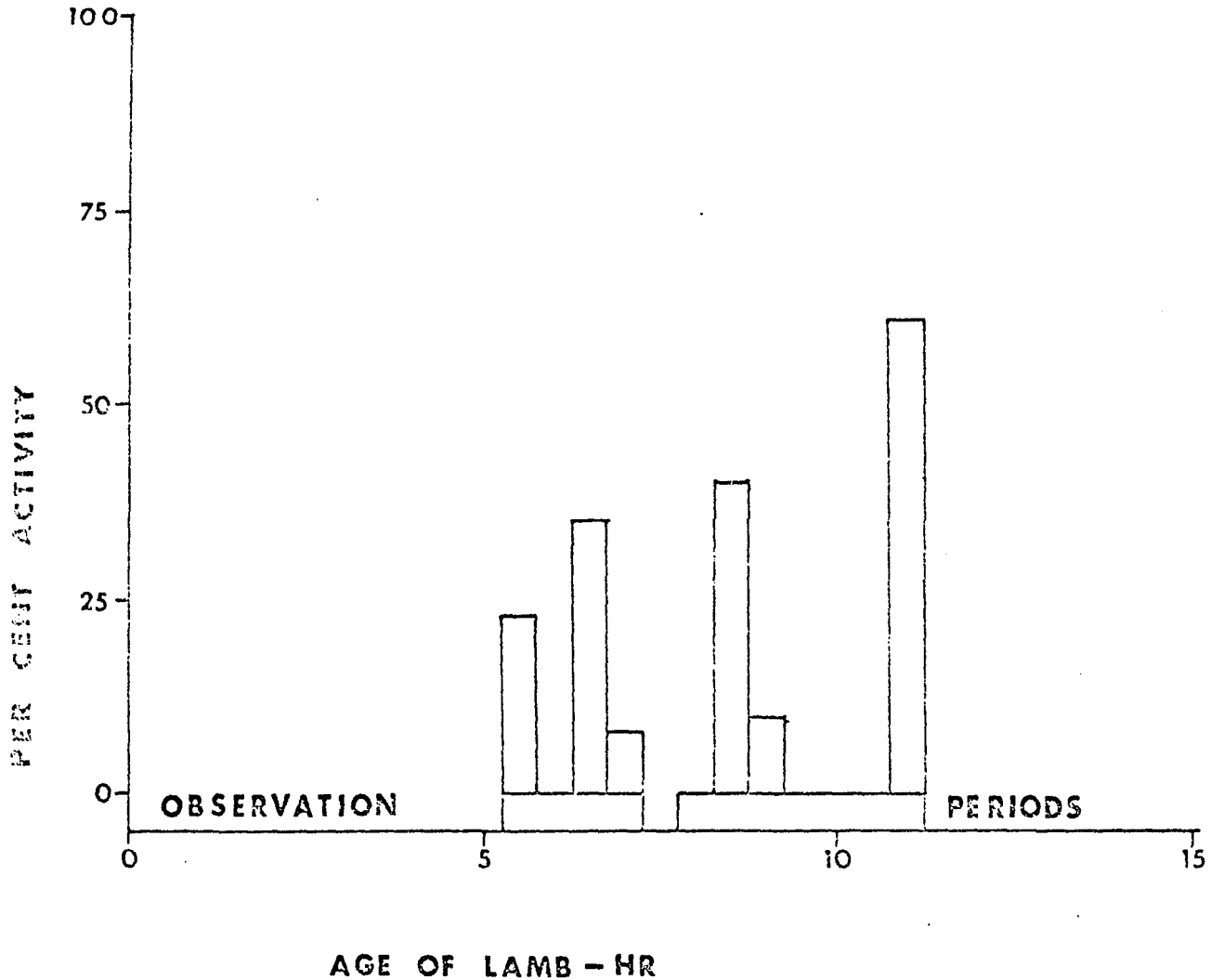


Fig. 14. Per cent activity for half-hour observation periods during the first day after birth for the lamb of 5/26. The age of this lamb is estimated. (Note that only half-hour observation periods with a minimum of 15 minutes of observation are considered.)

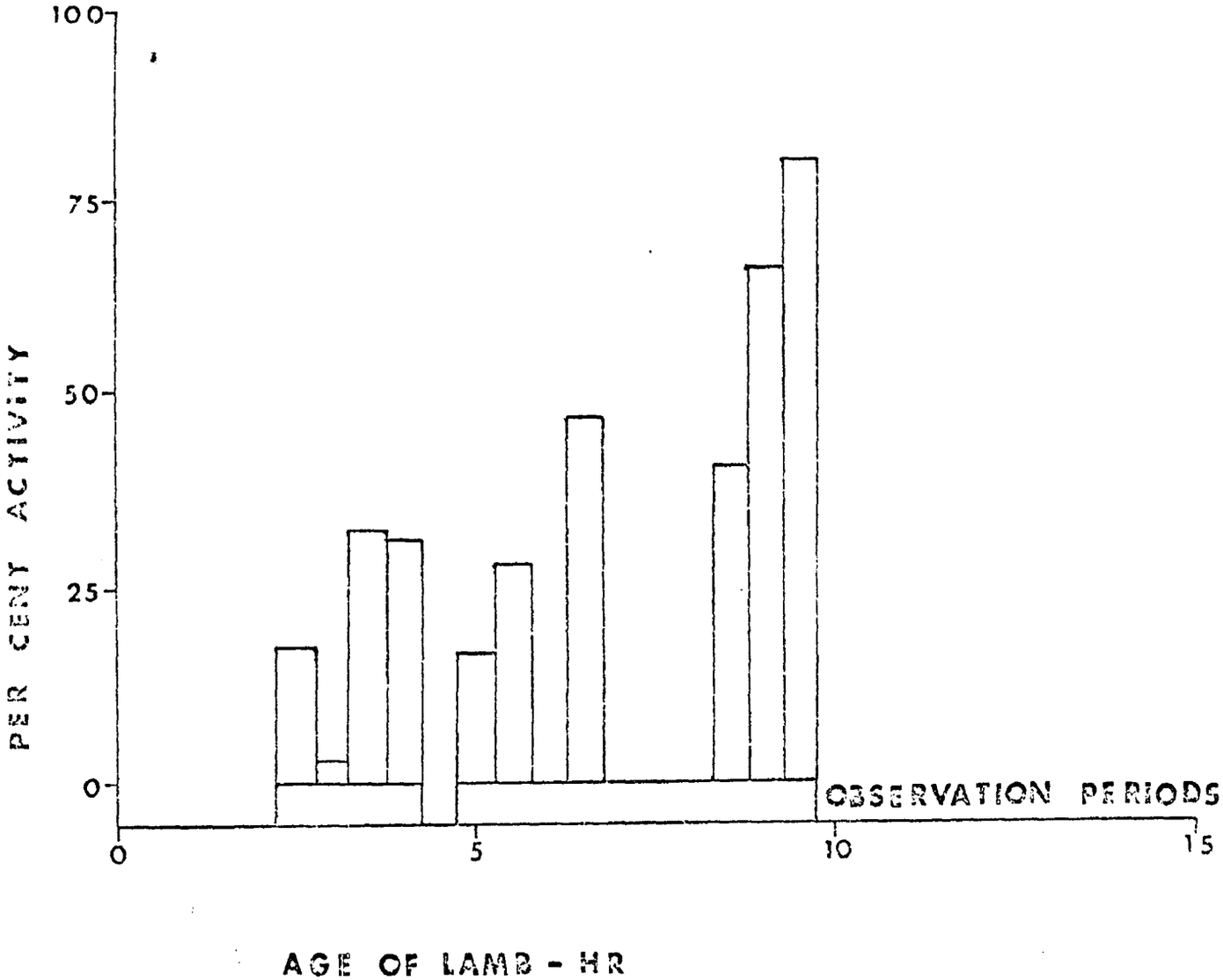


Fig. 15. Per cent activity for half-hour observation periods during the first day after birth for the lamb of 5/28. The age of this lamb is estimated. (See note on Fig. 14.)

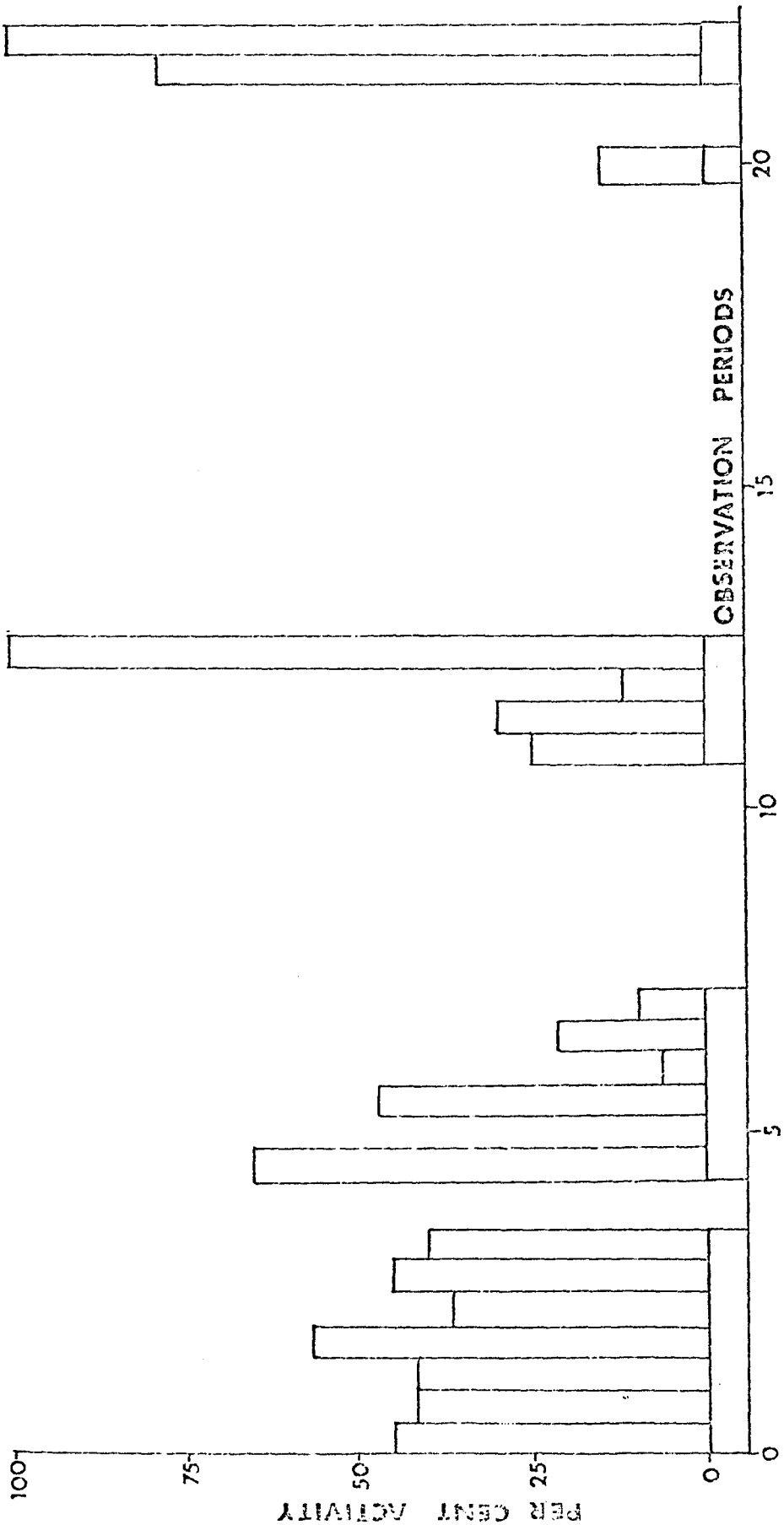


Fig. 16. Per cent activity for half-hour observation periods during the first day after birth for the lamb of 5/29. (See note on Fig. 14.)

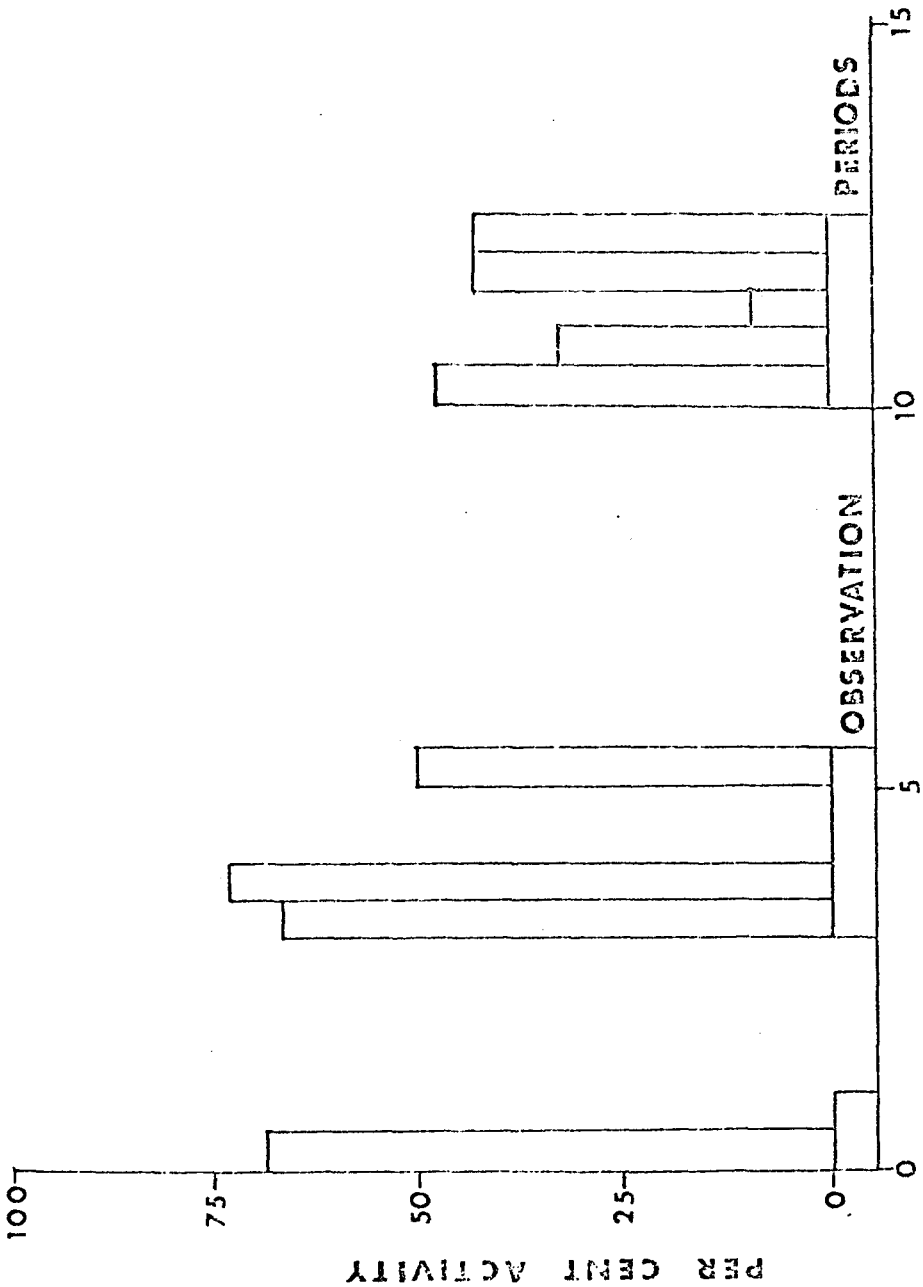


Fig. 17. Per cent activity for half-hour observation periods during the first day after birth for the lamb of 6/1. (See note on Fig. 14.)

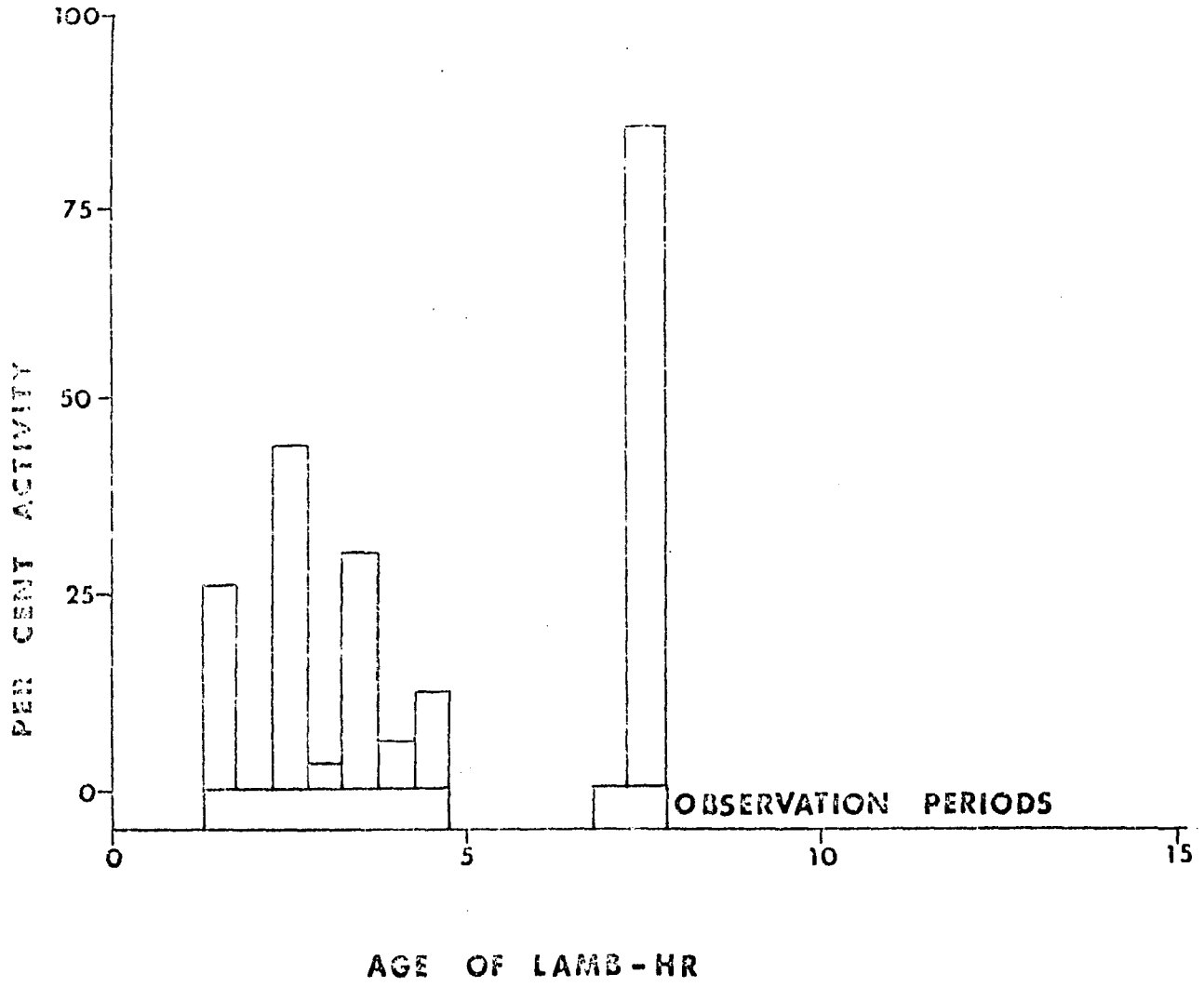


Fig. 18. Per cent activity for half-hour observation periods during the first day after birth for the lamb of 6/6. The age of this lamb is estimated. (See note on Fig. 14.)

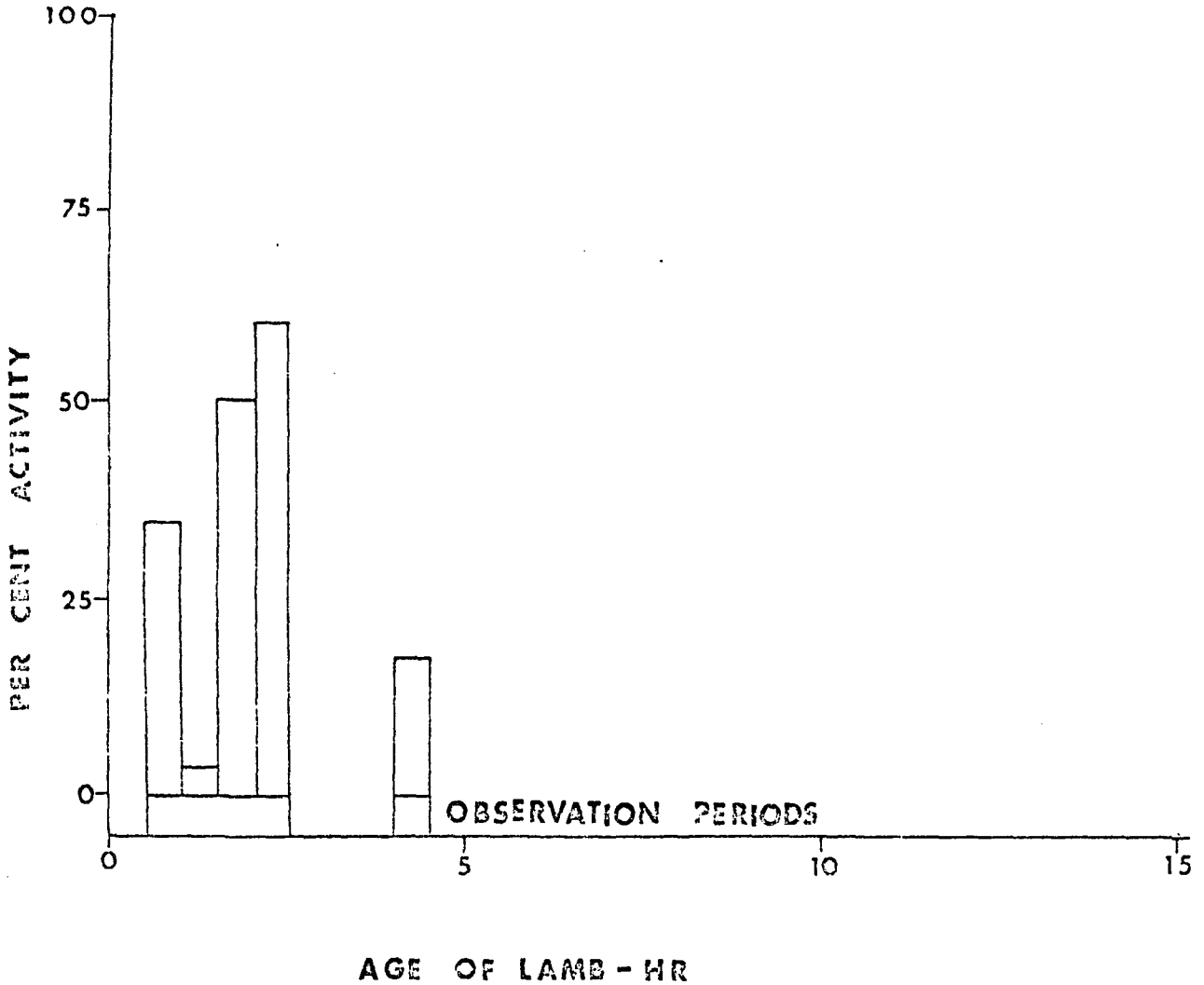


Fig. 19. Per cent activity for half-hour observation periods during the first day after birth for the lamb of 6/17. (See note on Fig. 14.)

TABLE 7. LENGTH OF ACTIVITY AND REST PERIODS FROM BIRTH TO 3.63 HOURS AFTER BIRTH FOR LAMB OF 5/29

Time	Age of lamb, hr	Activity, min	Time	Age of lamb, hr	Rest, min
1546-1603	0.00-0.28	17	1603-1620	0.28-0.57	17
1620-1702	0.57-1.27	42	1702-1723	1.27-1.62	21
1723-1742	1.62-1.93	20	1742-1749	1.93-2.05	7
1749-1752	2.05-2.10	3	1752-1807	2.10-2.35	15
1807-1817	2.35-2.52	10	1817-1832	2.52-2.77	15
1832-1847	2.77-3.02	15	1847-1905	3.02-3.32	18
1905-1923	3.33-3.63	18			

1702 (01:16) becomes a single activity period for the lamb. The ewe sustained this activity with frequent activation of the lamb, either smelling, licking, or pawing it. She activated the lamb to get up from resting 7 times during this single activity period. During the 5 following activity periods, the ewe activated the lamb 2, 0, 1, 2, and 0 times for an average of 1.0 activation per activity period. All activity periods of the lamb from birth to the start of regular nursing were initiated by the ewe with two exceptions: a short 3 minute activity period at 1749 (02:03), and the activity period at 1905 (03:19).

The long 42-minute activity period from 1620 to 1702 sustained by the ewe's frequent activation corresponds with the duration of crawling for the lamb. The lamb began most of the short activity periods previous to 1651 (01:05) with a short session of crawling and then later getting successfully to its feet. At 1651 the lamb began a 10-minute activity period during which it remained on all four legs for the entire duration. And, as noted, after this activity the activation frequency of the ewe dropped greatly. The ewe may still, as postulated for the postpartum pawing period, be reacting aggressively toward a lamb that is acting "abnormally" by crawling. For five of the activations considered in this long activity period, the ewe pawed the lamb, the form of activation so common during the postpartum pawing.

I do not have a clear record of the end of crawling for the other lambs observed during this period. The lamb of 6/17 crawled back up to the birth bed at 1900 (00:30), and then at 1902 got to its feet. No crawling was noted in the activity periods during the next 30 minutes, but the record is very unclear as to just what the lamb was doing,

since I was trying to photograph the lamb. Nor is it clear from the record whether the ewe initiated the frequent activity periods through 1931 (01:01). The lamb of 6/1 crawled back up to the birth bed at 2221 (00:18) and rested in the birth bed with the ewe until 2300, when observation was discontinued. This unusual inactivity may be explained by the fact that the birth occurred so late in the evening. As shown in the per cent activity graphs for the ewes and lambs of 5/29 and 6/17, the period just before dusk is a period of very little activity. Or perhaps it is best explained by the fact that the ewe appeared to be very young, 3 or 4 years old, and may have been primiparous.

The mean length of all activity periods for the lamb of 5/29 from birth to the start of regular nursing is 18; the mean length of all rest periods is 16. However, perhaps the second activity period for the lamb is best considered in a category by itself, as it is much longer than the others and, unlike the others, sustained by the frequent activation of the ewe. The mean length of the 5 later periods is 13. Thus, the general pattern during this period from 1702 to 1923 (01:15 to 03:37) is activity periods averaging 13 minutes, initiated by the ewe but sustained by the lamb, alternating with rest periods averaging 15 minutes. Activity and rest data for the lambs of 5/26, 5/28, 5/29, 6/1, 6/6, and 6/17 are given in Figs. 20-25.

Contactual behavior of ewe and lamb:

The ewe's licking of the lamb may be almost continuous during the activity periods of the first hour or more after birth. The ewe of 5/29 frequently licked her lamb in the period from 1620 to 1646 (00:34 to 01:00). The lamb of 6/6 was visibly wet on its head and shoulders

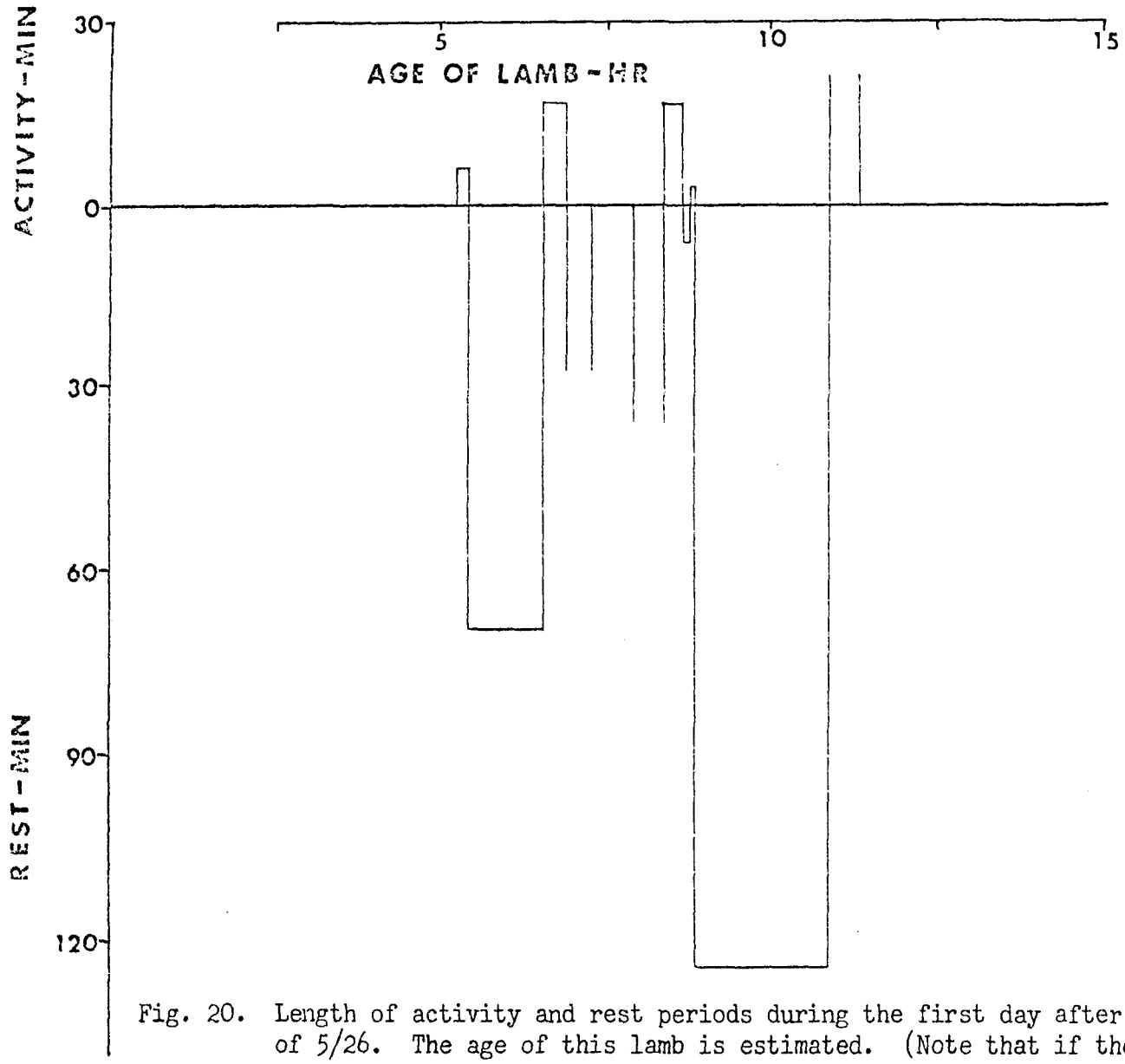


Fig. 20. Length of activity and rest periods during the first day after birth for the lamb of 5/26. The age of this lamb is estimated. (Note that if the beginning or end of a particular activity or rest period was not observed, the distal end is left off the bar in the illustration.)

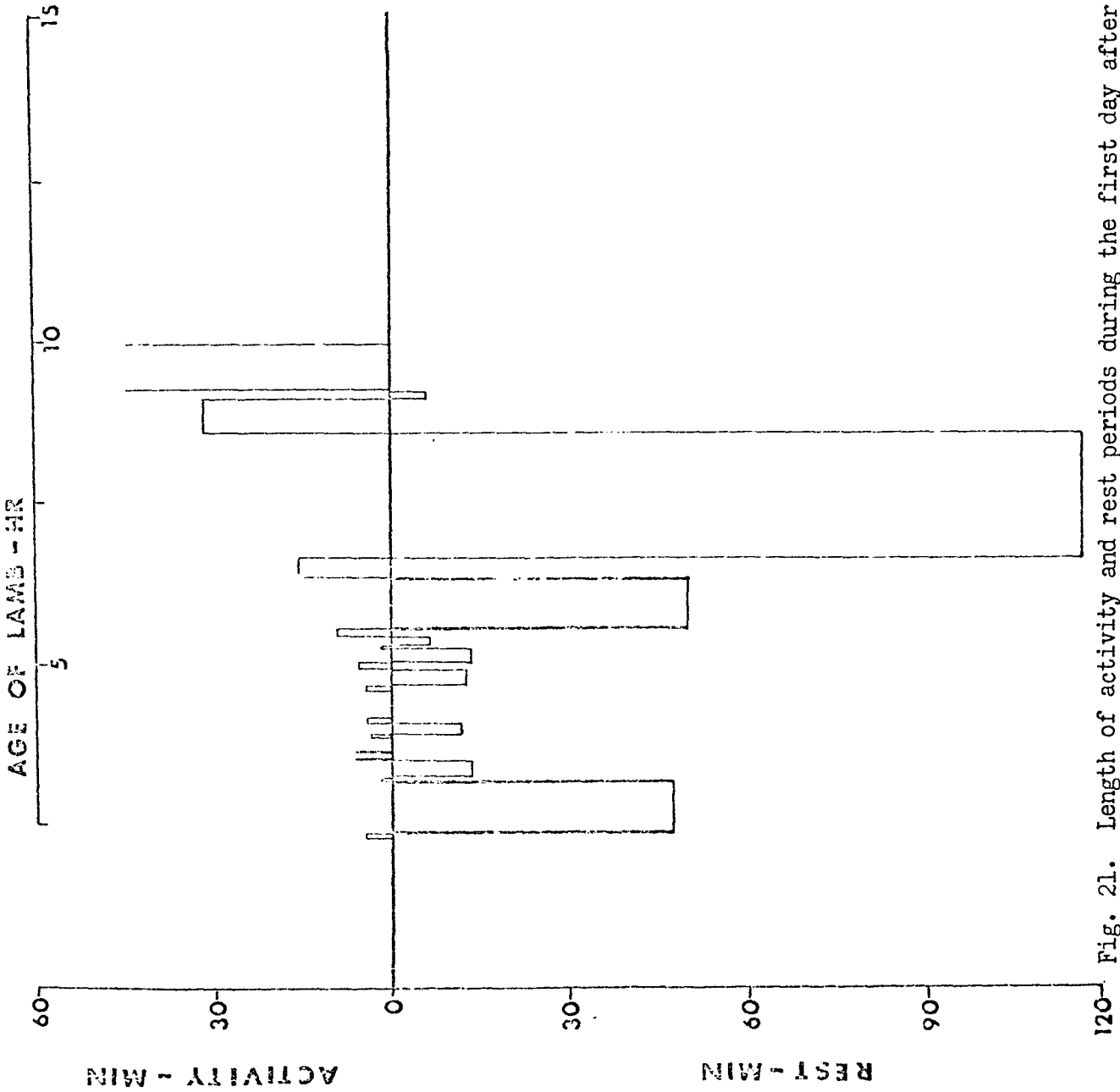


Fig. 21. Length of activity and rest periods during the first day after birth for the lamb of 5/28. The age of the lamb is estimated. (See note on Fig. 20.)

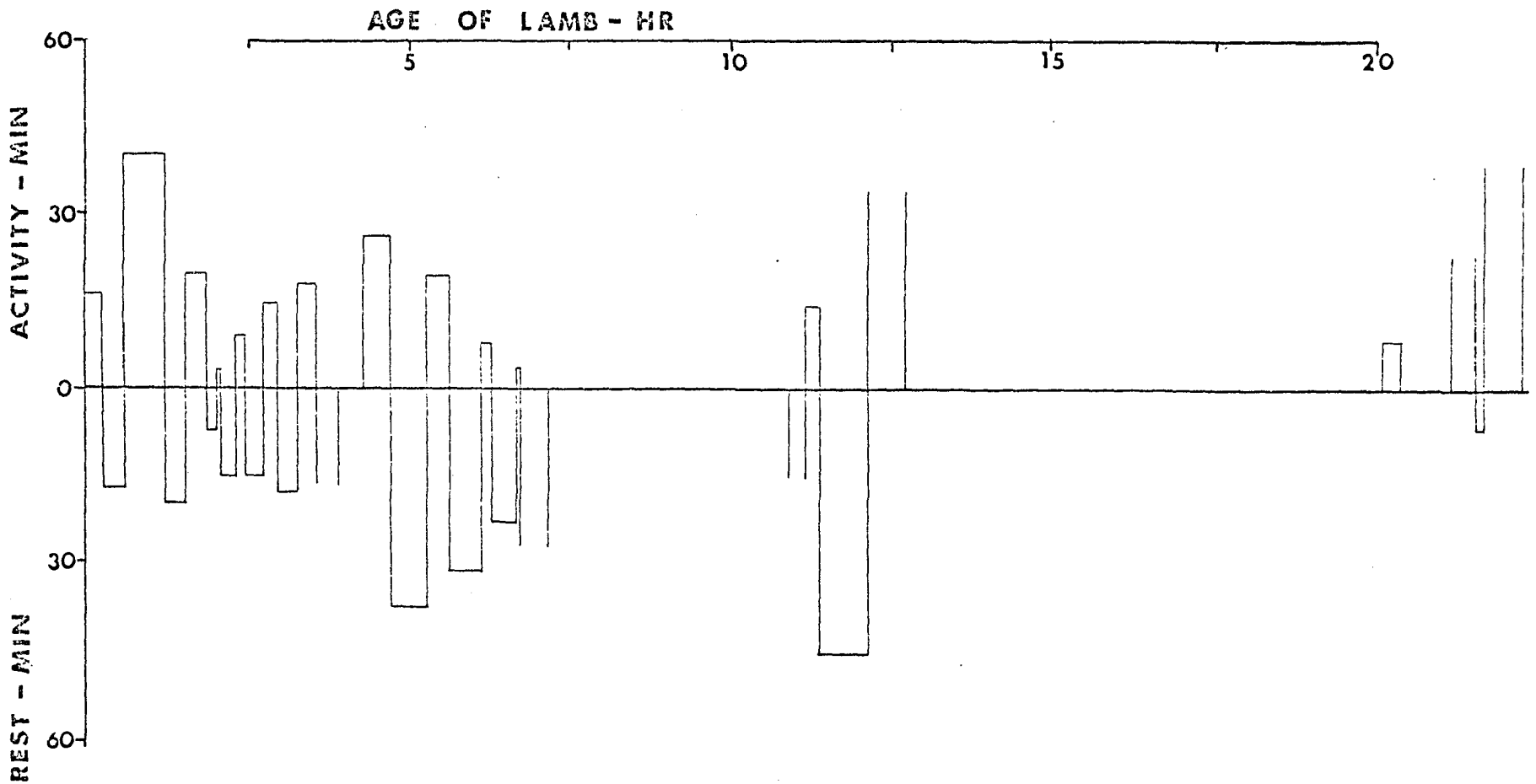


Fig. 22. Length of activity and rest periods during the first day after birth for the lamb of 5/29. (See note on Fig. 20.)

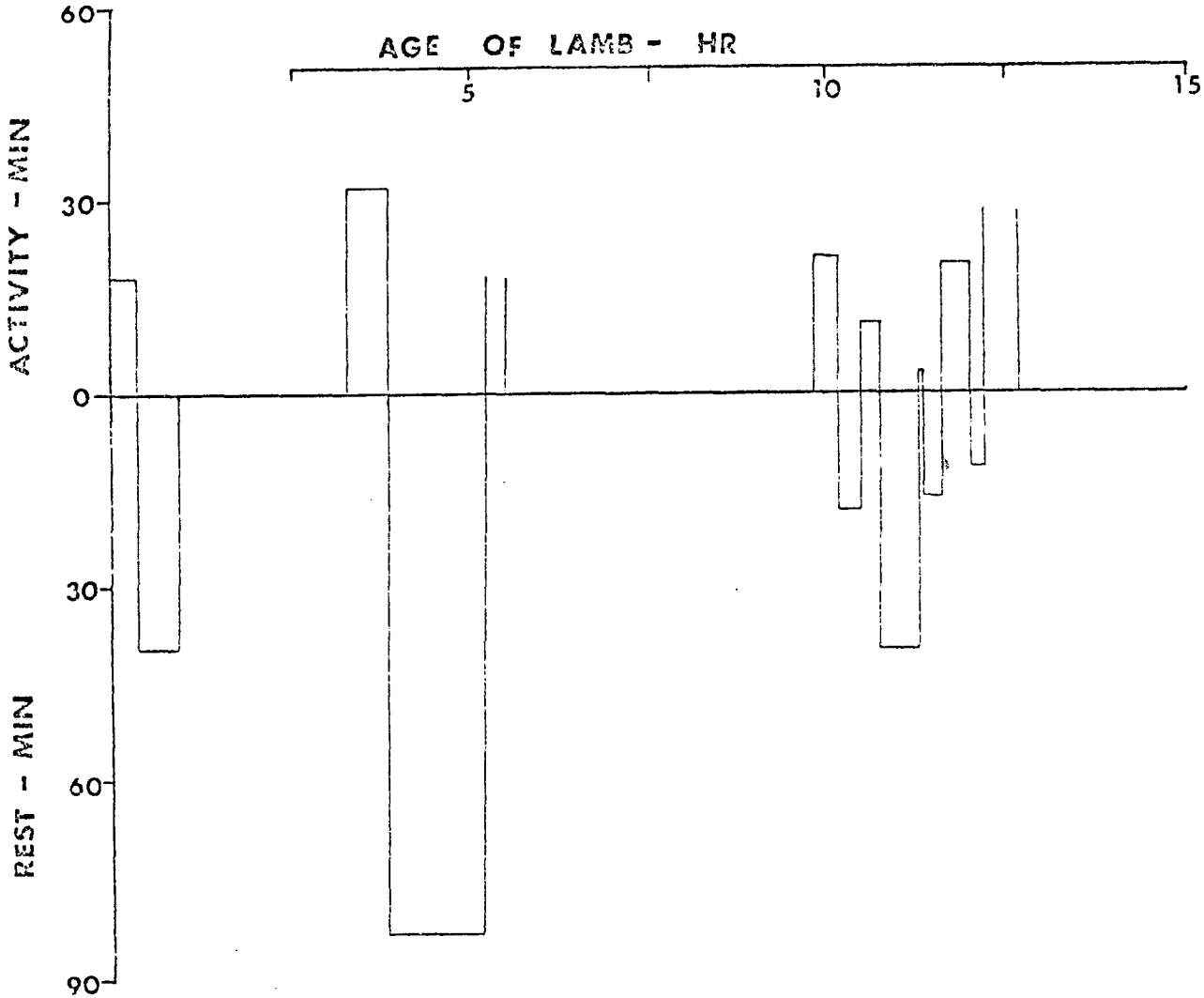


Fig. 23. Length of activity and rest periods during the first day after birth for the lamb of 6/1. (See note on Fig. 20.)

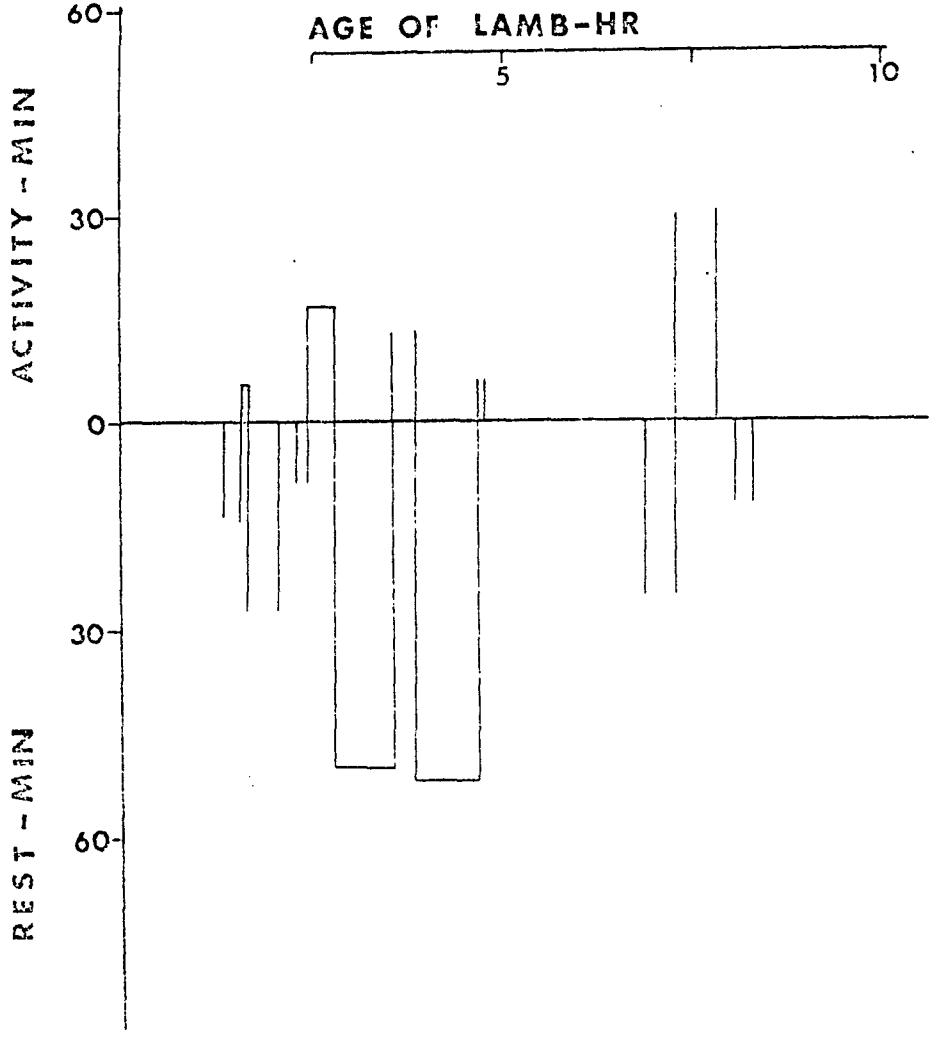


Fig. 24. Length of activity and rest periods during the first day after birth for the lamb of 6/6. The age of this lamb is estimated. (See note on Fig. 20.)

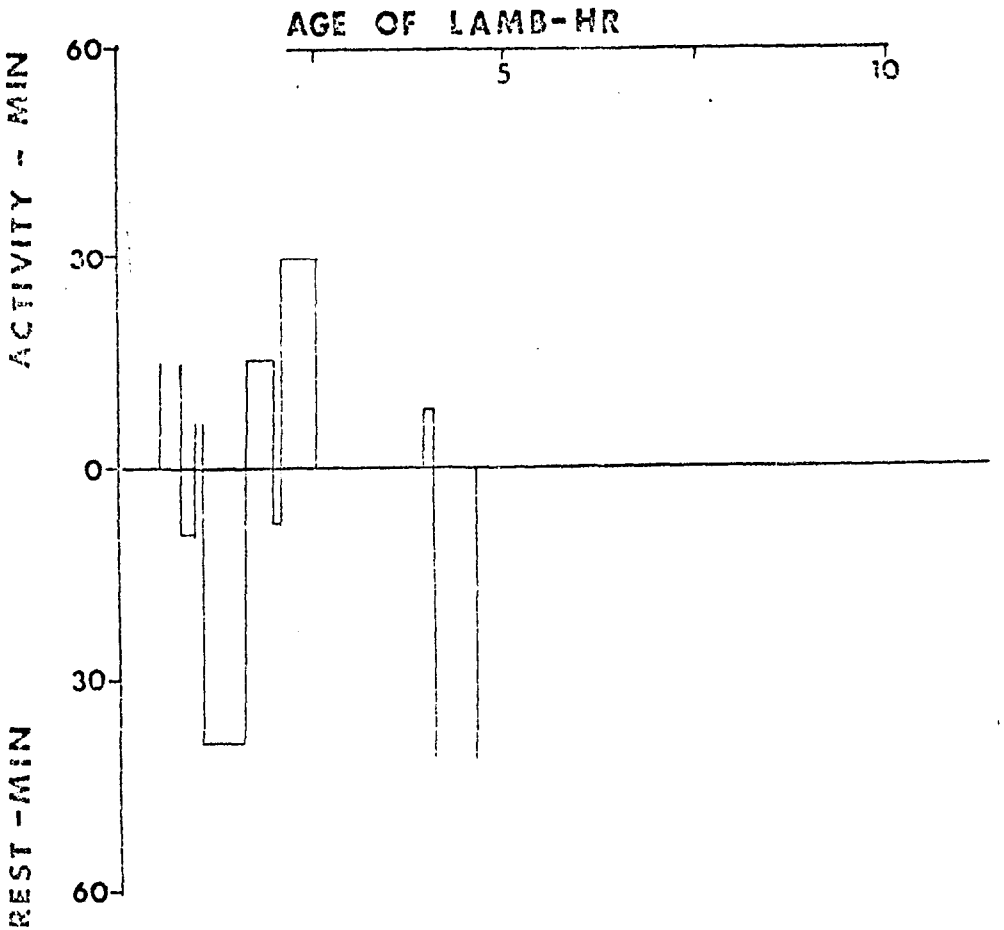


Fig. 25. Length of activity and rest periods during the first day after birth for the lamb of 6/17. (See note on Fig. 20.)

when first observed at 0937, and the ewe frequently licked it during her activity period from 0943 to 0956. The ewe of 6/17 licked her lamb frequently during the period from 1930 to 1951 (01:00 to 01:21). Licking the lamb, especially the anal area, is a common pattern in the activity periods of the first hour or more after birth. Later it is often used as a means to activate a lamb that is resting, but it ceases to be nearly continuous during most activity periods.

The lambs may begin to initiate contact with the ewe within an hour or two after birth. They address their attention to the ewe's face and head and are often seen tottering around in front of the ewe as she rests, frequently touching noses with her and indulging in general facial nuzzling. The lamb of 5/29 began such behavior at 1700 (02:15) and continued to nuzzle the ewe in every activity period through 1924 (03:38). The lamb of 6/17 frequently nuzzled its mother's face during the period from 2034 to 2100 (02:04 to 02:30). The lamb of 6/1 was similarly involved at 0317 (05:12) on 2 June. The lamb of 5/26 was smelling the ears, eyes, and horns of its mother as she rested at 1352. Lent (1966:714) reported frequent facial contact between caribou cows and their newborn calves. Koford (1957:185) noted that as soon as the newborn vicuña can walk, it initiates "...mutual caresses by nosing the head of its mother." He continued (1957:186):

> Even when the infant licks her face and nose, the mother remains calm and continues to chew cud. On occasions mother and juvenile "kiss" for several seconds, their muzzles nearly touching, their tongues going rapidly in and out.

Altmann (1963:242) observed that day-old moose calves lick and rub their mothers' face and neck.

Neonatal play:

In these first few hours after birth, most lambs began to explore their environment, usually the area just above the birth bed. Once such a pattern begins, it soon becomes a favorite activity of the lamb; and in the subsequent activity periods the lamb frequently returns to the same general area, rock climbs and continues to explore, and then returns to the ewe. Sometimes lambs repeat this pattern several times in a single short activity period. On occasion the lambs might rest above the ewe; usually they rest in the birth bed at the upper side of the ewe. I have termed this type of exploratory behavior neonatal play.

The lamb of 6/17 began such play periods at 1930 (01:00) and made four or five such excursions above the bed in the next 1.5 hours. The lamb of 5/29 returned to play in the very crevice between two rocks up above the birth bed where it had rested after the postpartum pawing. This lamb began such play in the activity periods beginning at 1807 (02:30). During the next two activity periods, the lamb made six such trips exploring above the bed, and continued this play in each activity period through 2205 (06:25). The lamb of 6/1 was playing above the bed at 0840 (10:35) on 2 June and during the two activity periods between 0941 (11:37) and 1042 (12:39) made six such excursions. The lamb of 5/28 persisted in trying to climb a small rock outcrop just to the side of the birth bed when just several hours old. It climbed this outcrop 3 times during the period from 1207 to 1320. At 1301 the lamb climbed to the top of the outcrop, tried to turn around on it, and fell off. The lamb of 5/29 was observed playing above the birth bed at 1310 (21:24) on 30 May. Several lambs demonstrated their exuberance in the

form of excited jumps in the air: the lamb of 5/28 at 1444 and 1612, and the lamb of 6/1 at 0331 (05:30) on 2 June.

Marjoribanks-Egerton (1962:58-59) described similar play in an American bison calf just several hours old.

> Bucking was first seen in a calf only 35 minutes old, as it ran falteringly around its mother. A few hours later this calf galloped round the cow several times until, appearing tired, it returned to her and lay down. At this stage it did not go farther than 15 feet from her, and kept returning to her and touching noses with her before galloping off again.

The repeated nose-touching that she described is similar to that of the ewe and lamb described in the previous section. The basic play patterns are similar, also. Both include exploration, followed by return to and contact with the mother (frequently touching noses), and then more exploration. She went on to describe how this pattern persists in the solitary play of young bison during the first 5 days of life. The calves would gallop around their mothers in larger loops and circles than on the first day, "...but always returned to her after each circuit, before galloping off again." She then described two calves playing in the water of a lake shore, probably for the first time as one calf was only 2 days old and the other 4 days old. The basic play pattern was the same: they splashed in the water, then returned to their mothers, then back to the water, etc. She wrote (1962:60):

> This return to the mother after the first brief contact with something new, followed by return to the object again, has been seen in other young animals, particularly monkeys (Harlow and Zimmerman, 1959). The mother is treated as a "base" from which to explore and investigate. Whenever it is frightened, the infant runs back to its mother.

Lent (1966) described similar exploratory runs followed by rapid

return to the mother in infant caribou as early as the first day of life.

In that such play activities in newborn lambs usually occur above the birth bed, one might imagine survival value in this tendency to go uphill for animals born on such steep slopes. The area above the birth bed is comparatively safe. Even when the ewe is resting, a fall will alert her, or her physical presence may terminate the fall. If the ewe is standing, she might stop the fall as was observed for the ewe of 5/30 and described on the activity chart. This tendency to go uphill was also evidenced when several lambs, those of 5/29 and 6/1, moved uphill during the pawing session soon after birth.

Ewe's attraction to the birth bed:

In the period from birth to the start of a regular nursing pattern, all ewes and lambs oriented their activities around the birth bed, with the exception of the ewe of 6/6. These ewes (5/28, 5/29, 5/30, 6/1, and 6/17) consistently rested in the birth bed, the lambs usually in the bed just above the ewe or occasionally several yards above the ewe in their play areas. Often, when the lamb would rest in the play area above the bed, the ewe would go up to the lamb and activate it and encourage it to return to the birth bed with her. This pattern is apparent for the ewe of 6/17 at 1931 (01:01), 2010 (01:40), and 2215 (03:45), and the ewe of 5/29 at 1844 (02:58). Except for such minor travels away from the birth bed, the ewes did not leave its immediate area. The ewe of 6/6 may have left the birth bed because of my presence. She encouraged her lamb to follow her up to the bed in which she had been resting the previous evening, and there they both rested at 0956. At 1018 the ewe stood up and stared at the

observer for 5 minutes and then apparently led her lamb below the birth bed behind a rock ledge, as they were resting 10 feet below the bed at 1025. The ewe may have led her lamb away from the birth bed because she knew something was above her, although she could not decide just what and therefore was not frightened enough to leave the area completely. During the following activity periods they remained below the bed and did not return until 1312. At this time, the ewe again showed an attraction for the bed, since she pawed the lamb, which had bedded down 5 feet from the bed, as if to encourage the lamb to join her in the bed. The lamb, however, remained where it was.

The ewes almost always paw at the birth bed before resting, often for extended periods of up to 15 seconds. Such frequent pawing of the bed seems much more extensive than the normal pattern of ewes with older lambs when they rest, although I have no quantitative data on this point. This pawing of the bed is especially frequent in the first hour or so after birth. For example, the ewe of 5/29 pawed at the birth bed extensively on four separate occasions in the 10-minute interval from 1555 to 1605 (00:09 to 00:19). At 1605 she arose a minute after bedding, pawed at the bed for 15 seconds, and then rebedded. The lamb of 5/26 imitated its mother and pawed at the bed before resting at 1202, 1355, and 1405. At 1355 the lamb had rebedded a minute earlier, then spent a minute trying to get to its feet. When it finally succeeded, it pawed at the bed a few times and rebedded. It appeared as though once the pattern was "learned," the lamb could not rest without doing it.

Postpartum rest of the ewe:

The ewe of 5/29 began a period of comparative rest about 1 hour

after birth, which lasted until about 3 hours after birth. During the period from 1651 to 1905 (01:05 to 03:19), a 2-hour 15-minute interval, the ewe was active a total of 10 minutes or 11% of the time. This compares with 47 minutes or 72% of activity during the first 1 hour 5 minutes after birth. During this rest period, the longest activity period of the ewe was 4 minutes and the mean 1 minute and 40 seconds. She would stand up, paw the lamb, which would get up and begin an extended activity period, and then the ewe would rebed. The ewe of 6/17 may have begun a postpartum rest at 2023 (01:53) as she had only one 2-minute activity period in the next 44 minutes of observation. At 2106 (02:36) I discontinued observation and did not return until 2213 (03:43). Definite postpartum rests for the other ewes were not observed, as all were invisible for long periods at this time. Perhaps this postpartum rest evidences the beginning and duration of contractions expelling the placenta. Although no contractions were observed, the behavior of the ewe is similar to that during the contractions before birth in that most activity periods are very short. During these short activity periods the ewe activates the lamb, often by pawing it, whereas before the birth she frequently pawed at the birth bed.

Most ewes began eating the fetal membranes soon after they were passed. The ewe of 5/29 began a more extended activity period at 1905 (03:19), thus terminating her postpartum rest. A minute later she began eating a long cord of the fetal membranes and continued eating them for about 5 minutes. The ewe of 6/6 stood up at 1043 with about 3 feet of membranes hanging from her. A few minutes later she began eating a long cord of these membranes. She shook her head often while

she ate, as if attempting to sever a bite. She ate the membranes for 5-10 minutes. Other observations of ewes eating the fetal membranes are the ewe of 6/1 at 0135 (03:32) on 2 June, the ewe of 5/28 at 1316, and the ewe of 6/17 at 2224 (03:54). Each ewe ate the membranes for 5-10 minutes soon after they were passed. I was unable to tell, of course, how much of the membranes the ewes actually swallowed or if some of the membranes remained uneaten. The only observations of placentophagy long after the placenta was passed were the ewe of 6/6 between 1312 and 1316 (2.5 hours after its passing), and the ewe of 6/1 at 0812 (10:09) and from 0819 to 0825 (10:16 to 10:22) on 2 June (ca. 7 hours after its passing). Several ewes displayed a lip curl posture (flehmen) when eating these membranes: the ewe of 5/28 at 1315 and the ewe of 6/6 at 1312. Marjoribanks-Egerton (1962:114) noted a similar behavior among American bison cows (and other bison) after sniffing a wide variety of objects including the placental membranes hanging from a cow before and after calving and mucus from a newborn calf (on the ground and on the calf itself). She suggested that the best explanation for this posture is that it in some way improves the sense of smell of the animal.

Hersher et al. (1963, Table 1) presented data showing that 74% of the domestic ewes in one study (N = 184) voided the placenta between 2 and 4 hours after birth.

Initiation of nursing:

In most cases the occurrence of the first nursing of the lamb was not seen, since all observations were made from above the sheep and, therefore, the teats and udder were not actually visible. When a lamb positioned itself under the udder, usually its head and neck were

not visible from this perspective, either. Therefore, it was almost impossible to tell when the lamb actually grasped the nipple and suckled for the first time. It was easier to record instances of active searching for the nipple when the lamb obviously was not very close to the teats. The lamb of 5/29 began searching for the nipple at 1724 (01:38). Earlier, at 1637 (00:52), it stood up under the udder but fell before any searching was possible. At 1723 the ewe arose, licked the lamb, and then pawed it. The lamb stood up, fell, then stood up again and went immediately under the udder. The ewe positioned herself over the lamb with hind legs slightly spread and remained in this position while the lamb searched for the nipple. Most ewes assumed a similar posture in these first nursing periods, perhaps thereby lowering the teats and making it easier for the newborn lambs to reach them. The lamb remained under the udder for a minute and may have suckled for the first time. At 1725 the lamb was searching on the right thigh and then moved to the front of the ewe and began searching the angle between the forelegs and the body. With the lamb searching at the wrong end, the ewe terminated this session by turning away, and the lamb fell several feet down a scree slide. The lamb of 6/17 was searching for the nipple at 2055 (02:25). The lamb first searched the angle between the forelegs and the body, then moved back under the udder for a minute and may have suckled for the first time. Such searching for the nipple at the forelegs and hind legs, as observed in these two lambs, is common in most newborn ungulates and is explained by the fact that udder-seeking behavior involves sucking motions directed at the angle formed between the legs and the body of the mother (the angle made by the horizontal and vertical

parts of the mother's body), as discussed by Hediger (1955:88-89) and Marjoribanks-Egerton (1962:46, 49-50). Other observations of lambs searching for the nipple are the lamb of 6/1 at 0137 (03:34) on 2 June, the lamb of 6/6 at 1044, the lamb of 5/30 at 0824 (03:10), and the lamb of 5/29 at 1906 (03:20).

The regular nursing pattern:

As mentioned above, the actual first nursing of most of the lambs could not be determined because of the nature of the observations. The one exception was the lamb of 5/30, which vigorously bunted at the udder as it suckled for the first time at 0832 (03:17). This initial suckling might be expected to be much later than the normal pattern, since this lamb spent the first 3 hours of life caught in a crevice in a snowbank. As mentioned before, the lamb of 5/29 may have suckled at 1724 (01:38) and the lamb of 6/17 at 2055 (02:25); both observations were much sooner after birth than that for the lamb of 5/30.

One might expect the success rate of these nursings in the first hours to be low, as in caribou (Lent, 1966:717), due to lack of motor development. However, after these initial nursings, one should expect the lamb's ability to find the nipple and suckle to improve rapidly, as in caribou and domestic sheep (Collias, 1956:223; Hersher et al., 1963:211). The beginning of a pattern of regular nursing can be determined for the lambs of this study from examination of the activity charts. Such assessments are 1906 (03:20) for the lamb of 5/29, 0137 (03:34) on 2 June for the lamb of 6/1, 1315 for the lamb of 5/28, and 1044 for the lamb of 6/6. After these proposed times for the start of a regular nursing pattern, all lambs began the following activity periods with nursing sessions. The beginning of this pattern corre-

sponds with the termination of the postpartum rest for the ewe of 5/29. The lamb of 5/29 spent most of the 5-minute period after 1906 (03:20) under the udder, while the ewe was standing still eating the fetal membranes. The lambs of 5/28, 6/1, and 6/6 were also under the udder for most of the 5-10 minute period during which their mothers were eating the placenta. Perhaps it is a common pattern for these events, the end of the postpartum rest for the ewe, the eating of the fetal membranes, and the start of the regular nursing pattern, to occur concurrently.

Ewe-lamb activity after stabilization of behavior pattern - approximately 3.5 hours to 24 hours after birth:

The ewe begins short feeding excursions away from the birth bed, and the lamb follows. Usually they return to the birth bed after the first few of these periods, which may last 5-25 minutes each. The lamb nurses at the beginning of most activity periods as well as at other times. The ewe terminates nursing by moving off to feed. Soon they travel farther from the birth bed during more extended activity periods and may feed lower on the cliffs. Usually this occurs between 8 and 13 hours after birth. Often they return to the high cliffs and rest in or near the birth bed during the remainder of the lamb's first day of life. Several ewes returned to the birth beds with their lambs to rest 20 hours or more after birth. One ewe and lamb were still in the isolation of the general birth area 26 hours after birth.

For purposes of analysis, I have divided the period after regular nursing begins into two intervals: one including the first 4 hours of this period (ca. 3.5-7.5 hours after birth), and the other extending from the end of the earlier interval to 24 hours after birth (ca. 7.5-24 hours after birth). Data for all six neonates, including both

per cent activity per half-hour observation period and the length of activity and rest periods, are presented in Figs. 14-25.

A complete profile of the behavior of the lamb of 5/29 is available for the period before regular nursing began, and the profile is almost complete for the interval comprising the first 4 hours of regular nursing. Therefore, some interesting comparisons can be made between these two periods (the period 00:00-03:30 vs. the period of 04:15-07:15) for this lamb. The mean per cent activity per half-hour observation period from 2000 to 2300 (04:15-07:15) is 25%, which compares with 44% for the earlier period. Therefore, the ewe seems to permit the lamb to rest longer during the later period, as is also evidenced by the activity and rest data. The mean activity period during the earlier period is 18 minutes, during the later period it is 14 minutes, while the mean rest period during the earlier period is 16 minutes, during the later period it is 27 minutes. The scattered observations for the other neonates during this later period seem consistent with this general pattern of longer rest periods than activity periods, but the means of the rest periods are consistently less than 1 hour. Thus, frequent short activity periods punctuate rest periods averaging two to three times the length of the activity periods. Such trends are best evidenced in the graphs of rest and activity periods for the six neonates (Figs. 20-25).

A total of 16 activity periods was recorded for the six neonates during the period including the first 4 hours of regular nursing. The lambs nursed during 14 or 88% of these periods, and the average length of nursing per activity period was 1 minute 45 seconds. During the later interval, extending to 24 hours after birth, 16 activity periods

were recorded. The lambs nursed during 10 or 63% of these periods, and the average length of nursing per activity period was 3 minutes 13 seconds. Thus, there may be a trend toward longer but less frequent nursing during the later period.

As is characteristic of most ungulates, the ewe frequently smells or licks the anal area of her lamb during the nursing periods of the first day of life. She often does this just before the nursing period begins or in the first few seconds after the nursing has begun. The ewe of 6/6 displayed the former pattern at 1258. Examples of this pattern occurring during the first seconds of the nursing period are the ewe of 5/26 at 1032 and 1342, and the ewe of 5/28 at 1348. Often ewes displayed this pattern later in the nursing periods, also. The lambs frequently wag their tails as they nurse, a movement that might ensure that this maternal attention is directed to this seemingly important area. Hediger (1955:95) noted that this tail-wagging is typical of all Bovidae. Lent (1966:717) found that caribou calves (under 3 weeks old) suckled significantly longer when licked by the cow during nursing.

It is more difficult to discuss quantitatively the activity patterns of the ewe and lamb during the period beginning 4 hours after the start of regular nursing (ca. 7.5-24 hours after birth). The increasing radius of activity of the ewe and lamb at this time usually prevents continuous observation for long periods. Often they will get up and begin an activity period, and in 10 minutes will have traveled 25 yards or more and out of view of the observer. Sometime during the first few hours of this period, between 8 and 13 hours after birth, the ewes began feeding excursions covering a much greater distance

than previous ones (perhaps 25-50 yards compared to 5-15 yards), and perhaps lasting from 30 minutes to over an hour. The lambs followed with frequent short rests. Perhaps such demonstrations of the strength of the lamb are evidence to the observer that the lamb has received adequate nourishment in the preceding nursings. I have presented in Table 8 the time of occurrence of such feeding excursions or other activities (such as flight from the observer) that evidence the greatly improved strength and mobility of the lamb. For the lambs of 5/26, 5/28, and 5/29, such long excursions followed long rest periods of 124, 116, and 45 minutes, respectively.

The ewe and lamb of 5/29 later returned to the high cliffs, and were observed resting in the birth bed at 1325 (21:39) on 30 May, and then observed just 30 yards west of the birth bed at 1749 (26:04). The ewe and lamb of 6/1 were resting in their birth bed at 1800 (20:00) on 2 June, and were still in the general area of the birth bed at 1930 (21:26). The ewe and lamb of 6/10 remained in the isolation of the general birth area until late in the afternoon of 11 June, about 20 hours after the birth of the lamb.

Activation:

Sometime after regular nursing begins the ewe and lamb become more synchronized in activity. My observations seem to indicate at least one form of activation—that of pawing the lamb—is much less frequent after this pattern begins than before. The ewe of 6/6 is an exception to this pattern and is considered separately. A total of 14 activity periods was recorded before regular nursing began for the five neonates other than 6/6, excluding the activity period just after birth. There were 10 examples of activation by pawing (0.71 pawing

TABLE 8. OBSERVATIONS OF FEEDING EXCURSIONS AND OTHER ACTIVITIES THAT EVIDENCE THE GREATLY IMPROVED MOBILITY OF LAMB

Lamb	Time	Age of lamb, hr and min	Activity of ewe
5/26	1615	10:00-12:00	feeding - During next 10 min they moved 20 yd lower in ravine and out of view. Visible again 10 min later, ewe still feeding.
5/28	1915	9:00-10:00	flight - Ewe became frightened as she watched 10 other sheep (apparently fleeing from something farther west in the cliffs) move by her. Lamb followed slowly but moved 30 yd and out of view to the east.
5/29	0416 on 5/30	12:30	feeding - During next 45 min moved 50 yd lower on the cliffs and out of view
6/6	1530	7:00-8:00	feeding - During next 45 min moved about 30 yd.
6/17	0700 on 6/18	12:30	flight - Ewe fled from observer. Lamb followed at a run, keeping up with ewe as they fled down the ravine (30 yd) and then west out of view.

activations per activity period). A total of 30 activity periods was recorded after regular nursing began for all neonates except 6/6. Only three examples of activation by pawing were seen (0.10 pawing activations per activity period). The ewe of 6/6 activated her lamb by pawing on five occasions in three activity periods after regular nursing began. This lamb appeared somewhat slow in developing a consistent following response. On one occasion the ewe fed 20 yards from the lamb, then returned to it and pawed it as if to encourage its following. The lamb got up but rested again in a few seconds, and the ewe went off again to feed. This occurred between 1620 and 1628.

First extensive feeding of ewe:

Several ewes fed for short periods even before regular nursing began. These feeding periods were very short, often less than a minute, and "sandwiched in" between other activities, such as licking the lamb or perhaps just after the ewe stood up and before she activated the lamb. Soon after regular nursing began the ewes began extended feeding periods of 5-25 minutes. The ewes terminated the lambs' initial nursing by moving off to feed, and usually continued feeding for the remainder of the activity period. The ewe of 5/29 began such feeding periods at 2018 (04:32). The lamb followed the ewe and apparently nursed frequently as the ewe fed. They both returned to and rested in the birth bed at 2030 (04:29). The first extended feeding of the ewe of 5/28 was at 1336.

First observed following by lamb:

As mentioned in the previous paragraph, the lamb of 5/29 followed the ewe on the first feeding excursion away from the birth bed. The lamb of 5/28 did not follow on the first feeding excursion, but at

1507 (estimated age = 5-6 hr) did follow the ewe 5 yards away from the birth bed while she fed. They both returned to rest in the birth bed. The lamb of 5/26 was following the ewe when first observed at 1030. Once the following response begins, it becomes the usual pattern in succeeding feeding excursions.

Summary of data on birth behavior and activity of ewe and lamb during the first day after parturition

Tables 9 and 10 summarize the birth behavior and related data for the four lambs of known time of birth: 5/29, 5/30, 6/1, and 6/17. Many of the apparent irregularities in these tables may be attributable to discontinuous observation. If the time of first appearance of a certain activity seems very long for a particular lamb, often a glance at the activity chart for that lamb will show that this was merely the first observed instance of this activity and that it may have occurred much earlier during a lapse of observation.

TABLE 9. SUMMARY OF DATA ON BIRTH BEHAVIOR AND ACTIVITY OF EWE AND LAMB DURING THE FIRST DAY AFTER PARTURITION

Lamb	5/29	5/30	6/1	6/17
Length of isolation before birth, hr:min	00:36	12:30	2:25	4:00
Interval between onset of heavy panting and parturition, min	10		42	
Interval between first appearance and final expulsion, min	10		15	
Time of day of birth	1546	0515	2203	1830
Interval between birth and first pawing of lamb by ewe, min	6		6	
Interval between birth and peak of postpartum pawing, min	8–10		8–10	
Interval between birth and end of ewe's first activity period, min	20		19	26
Interval between birth and first walking on front knees, min	5		13	
Interval between birth and first walking on all four legs, min	15			32
Interval between birth and end of crawling, hr:min	1:05	3:20		
Interval between birth and appearance of neonatal play, hr:min	2:30			1:40
Interval between birth and lamb's first nuzzling of ewe, hr:min	1:54		5:14	2:28
Interval between birth and first searching for nipple, hr:min	1:38	3:10	3:18	2:25
Interval between birth and postpartum rest of ewe, hr:min	1:05–3:20			1:53–2:36
Interval between birth and passing of placenta, hr:min		2:50		2:24

TABLE 9. (continued)

Lamb	5/29	5/30	6/1	6/17
Interval between birth and first eating of placenta, hr:min	3:20		3:32	3:54
Interval between birth and start of regular nursing pattern, hr:min	3:20		3:34	
Interval between birth and first extensive feeding of ewe, hr:min	4:32			
Interval between birth and first following of lamb as ewe feeds, hr:min	4:32			
Maximum time after birth spent in isolation of general birth area, hr:min	26:04		21:26	

TABLE 10. SUMMARY OF NUMERICAL DATA ON ACTIVITY AND REST OF LAMBS DURING THE FIRST DAY AFTER PARTURITION

Lamb		5/29	6/1	6/17
Birth to start of regular nursing	Mean per cent activity per half-hour observation period	44		37
	Mean length activity period, min	18		17
	Mean length rest period, min	16		19
Start of regular nursing to 4 hr later	Mean per cent activity per half-hour observation period	25		
	Mean length activity period, min	14		
	Mean length rest period, min	27		
End of above interval to 24 hr after birth	Mean per cent activity per half-hour observation period	51	35	
	Mean length activity period, min	23	17	
	Mean length rest period, min	22	21	

Note: data are listed only for those lambs under continuous observation for at least 2 hr in the particular interval

Continued development of ewe-lamb behavior

First contact with other sheep:

Sometime between 24 and 48 hours after birth most ewes and lambs move lower on the cliffs and terminate their period of isolation. I was unable to individually identify any of the ewes and lambs after they rejoined the other sheep. Continuous observation of individual animals ended at this time, and there is almost no information on the progression of events in succeeding days. Probably the lambs remain in very close association with their ewes for several more days with very minimal association with other sheep. Several times I observed lambs following their ewes closely, resting frequently, and not joining in play with other lambs nearby; but I had no way of knowing exactly how old they were. Geist (1967a:29) believed that lambs begin to associate with other lambs about 1 week after birth. The infant vicuña begins to associate with other juveniles about 1 week after birth, also (Koford, 1957:187). American bison cows stay away from the herd for 1-2 days (Marjoribanks-Egerton, 1962). The calf does not join in play groups until it is about 1 week old, because the cow does not permit other calves to approach and play with it.

The ewe-lamb subgroup:

Observations confirmed the existence of a ewe-lamb subgroup during the first month or so of the lamb's life. Ewes with lambs are often seen grazing and more often resting together. In the same way, barren ewes and yearlings form a loose subgroup at this time of year. Neither of these subgroups is closed, of course. For example, a few yearlings and apparently barren ewes are often seen resting with a

group composed of ewes and lambs.

Table 11 contains observations of four predominately ewe-lamb groups resting on a favorite platform low in the ravine just west of the Skilak Peak. This particular resting spot lies just inside the western edge of the Skilak Cliffs and offers good visibility all around. The sheep often return to the cliffs after grazing on the more meadow-like slopes farther west and rest on this platform. (A much-used sheep trail leads from this resting spot to the slopes to the west, one of the few crossing the rugged western escarpment of the cliffs.) Probably the ewes with lambs like the security of the cliffs when resting. Thus, this may be a traditional resting spot for ewes with lambs during the lambing season. All observations in Table 11 contain an equal number of ewes and lambs except the 8 June observation. However, the 6 extra ewes balance the 6 yearlings; perhaps this group is composed of 16 ewes with lambs, 6 barren ewes, and 6 yearlings.

Murie (1944:92) thought the ewe-lamb subgroup is merely a reflection of the tendency of ewes with lambs to remain near such secure terrain.

> The tendency for ewes with lambs to bunch up is probably a natural outcome of their all having the same inclination to remain in the rougher terrain. Later there is more intermingling of the ewes with lambs and those without lambs.

On Surprise Mountain ewes with lambs seemed to intermingle more with other ewes and yearlings when on the summer range in July and August.

The two lambs first observed on 25 May 1967 offer further evidence for the existence of a ewe-lamb subgroup. One of the ewes was missing her right horn and therefore was easily recognizable and was

TABLE 11. OBSERVATIONS OF FOUR PREDOMINATELY EWE-LAMB GROUPS RESTING ON A PLATFORM LOW IN THE RAVINE WEST OF THE SKILAK PEAK

Date	Time	Ewes	Lambs	Yearlings
6/8/67	1030	22	16	6
6/13/67	1800	10	10	
6/25/67	1630	33	33	
6/26/67	1335	12	12	5

observed frequently (10 times) through 22 June. She remained in the company of the other ewe (whose horn type was identifiable as long as she remained with the one-horned ewe) and lamb through 28 May 1967; thus, they were a group of four for this period.

Other observations indicate the existence of a barren ewe-yearling subgroup at this time. On several occasions large groups of 30 or more ewes and yearlings were seen in the Russian River Cliffs, while no ewes with lambs were observed there in May and June. Similar large groups of ewes and yearlings were frequently observed on the slopes west of the Skilak Cliffs.

Marjoribanks-Egerton (1962:52-53) described a similar cow-calf subgroup in American bison. The fact that lambs, like young bison, come to prefer each others company to that of older sheep was shown on several occasions. On the evening of 25 June at 2300 I noticed that all the sheep (about 33 ewes and 33 lambs) that were observed there earlier in the evening had bedded down about 30 yards east of their favorite resting spot. The lambs were resting close together in small groups with just a few ewes scattered among them. Most of the ewes rested to one side of the lambs. Geist (1966:144) referred to similar "juvenile groups within female bands" in elk and cattle and pointed out that lambs "...appear to favour the company of equals, but follow adults once these move on."

Play:

The ewe-lamb subgroup may be viewed as a social tradition that facilitates interaction between lambs, the main form of which is play. Observations of play among lambs are listed in Table 12.

The play periods of 13 June 1967 and 25 June 1967 both occurred

TABLE 12. OBSERVATIONS OF PLAY AMONG LAMBS

Date, time	Location	Lambs	Type of play
5/14/67, 1800	SE corner of mountain	5*	jumping
5/24/67, 0910	SE corner of mountain	6*	clashing horning the ground
5/25/67, 1105	Skilak Cliffs	2	jumping racing
5/27/67, 2000	Skilak Cliffs	2	jumping (one jumps over ewes back)
6/13/67, 1830-1915	Skilak Cliffs	10	jumping horn-threat racing threat-jump mounting pawing clashing butting
6/22/67, 1730-1800	Skilak Cliffs	5	racing jumping
6/25/67, 2000-2130	Skilak Cliffs	30	same as those types listed for 6/13/67
7/14/66, 2000-2030	Russian Mountain	6	king-on-the-hill
7/21/66, 1000	Russian Mountain	15	romping on snowbank

*These are "short" yearlings.

on what may be a traditional play area for lambs, midway down the ravine just west of the Skilak Peak and 20 yards above the rest area for ewes and lambs described earlier. In fact, each of these play groups was apparently composed of the same lambs that had been resting on the platform earlier in the afternoon (same number of lambs playing and resting in each case). This playground was a large eroded basin about 30 yards across that perhaps offered good footing for their antics. Races often began in this playground. The lambs might race east or west of the basin about 50 yards and then return to it for other antics of mounting, butting, clashing, jumping, and pawing the ground. I watched about 30 lambs play in this manner for over an hour on the evening of 25 June 1967. Koford (1957:187) described similar racing among juvenile vicuñas.

> Often a group of young run away from the adults and back, several times in succession, one then another in the lead. At two weeks of age the young rarely race more than 50 yds from the family group, but at one month of age they run away as far as 100 yds, and at several months of age, twice as far.

The jumping that takes place in play periods is difficult to describe. Like racing, the excitement of the contest appeared contagious; each jump taken as a challenge by another lamb to outdo it. Their game seemed to be to jump in the air and kick their heels in as many directions as possible before returning to the ground. On three occasions I observed ewes begin this sort of running and jumping, which may be displacement behavior employing a juvenile play pattern. On each occasion the ewes spotted me observing them from several hundred yards distance, stared at me for a considerable time, and then began this sort of running and jumping. Their lambs followed with

similar jumping, as if in play. Each situation presented the ewes with a conflict: to continue feeding or flee the unclearly defined danger. This situation seems similar to that likely to induce displacement head-bobbing in caribou, as described by Lent (1966:719). This head-bobbing was likely to occur:

> Upon alarm or suspicion when man, predators, or unusual objects (such as a tent flapping in the wind) are observed, [especially, p. 720] ...when the source of disturbance is not immediate or clearly defined, usually in the moment between the end of feeding activity and the beginning of fright or escape responses.

Müller-Schwarze (1968) described similar running and leaping play patterns in two captive fawns of the blacktailed deer (Odocoileus hemionus columbianus) and noted (p. 149) that "running is the climax of the play bout ...." If intensive running is the climax of play bouts of lambs, also, then the 13 June 1967 and 25 June 1967 observations must each represent several play bouts. On each occasion several bouts of intensive running, 10-20 minutes apart, were observed.

During the play periods of 14 May 1967, 24 May 1967, and 21 July 1966 several ewes joined in the play of the lambs. On 21 July 1966 the ewes were baby sitters for the group of lambs whose mothers were feeding in the valley below. On 24 March 1967 a 2-year-old ewe was clashing (as defined by Geist, 1966) with two yearlings. Most other observations of play among adult sheep occurred under the stimulus of walking across the isolated snowbanks that remained in late spring and early summer. This behavior has been observed in other ungulates such as caribou and elk (Lent, 1966). This play among sheep, as in caribou, occurred mostly on warm days in May and June. On 20 May at

1000 I watched a group of eight frolicking, clashing rams play on a snowbank for 20 minutes.

The play of 13 June 1967 ended abruptly at 1930. A marmot whistled, all the lambs rushed to their mothers, and all left the area. About 10 minutes later I saw a black bear (the sheep may have seen or smelled the bear earlier; therefore, their flight was not necessarily in response to the marmot's whistle.) feeding near the playground of the lambs.

The two lambs playing on 25 May 1967 and 27 May 1967 were the first lambs observed during 1967 and were discussed earlier. The lamb of the one-horned ewe also participated in the play periods of 13 June 1967 and 22 June 1967. On the earlier occasion it ran to her when the play abruptly ended and all sheep left the area. On the later occasion she appeared from the west where she had been feeding, and her lamb immediately stopped playing and began to nurse.

These observations of play are a good qualitative index of the health of the lambs and the population itself. Geist (1967b:21) had this to say on the subject.

> I never thought anything as lively as little Stone's lambs could exist. Barnyard lambs are downright dead by comparison. Not all mountain sheep lambs are lively, however, for those with the misfortune of being born on an over populated, poor range are everything but spunky. The amount of activity of lambs I found to be a good indication of how well or how badly the population was faring. Listless lambs were usually small. They received little milk since the ewes had little to give. The lambs grew poorly and remained small throughout, maturing literally years later than good lively lambs.

In comparison, the Surprise Mountain population showed none of these symptoms in 1966 and 1967.

Movement to summer range:

The sheep began using the Skilak Valley on 15 June. A week later the first band of rams was seen in Surprise Valley. I left the study area on 29 June and returned on 12 July. The sheep were then using Russian Mountain. The summer range comprises virtually the entire alpine area of Surprise Mountain.

Discussion - maternal behavior

Birth behavior and nutrition:

Considering that the Surprise Mountain ewes entered the lambing season of 1967 in good nutritional condition, and that the Surprise Mountain sheep population itself was of high quality, the data of this study should be representative of the birth behavior of healthy ewes. This poses the interesting question of what to expect if the ewes had entered lambing under a very different set of conditions, perhaps a very severe winter or heavy snowfall in April or May.

Many researchers have commented upon the correlation between nutritional condition and the level and sequence of endocrine activity at birth and its effects on maternal behavior. For example, Hersher et al. (1963:207-209) described the occasional "poor" mother in domestic sheep.

> An occasional mother (especially a poorly fed one with delayed milk flow) will pay little attention to her young until some time after birth, or even ignore it completely. Wallace (cf. Table 1) found that many of these "poor" mothers had experienced especially difficult labors.

Their reference to the common occurrence of delayed milk flow among these "poor" mothers seems to offer indirect evidence of the correlation between the level of maternal hormones (especially those involved with milk secretion) and maternal behavior. Hediger (1955:90) noted that such disturbances in the mother-child relationship after birth as insufficient lactation and defective rearing of the young have in many cases been proved to have "...a close connection with hormone metabolism." Leathem (1961:666) wrote of the "...inter-

dependence between nutrition and the endocrine glands, including those with reproductive functions" and that nutrition does "...influence the synthesis and release of hormones." Thus, there appears to be a physiological basis for the supposition that the birth behavior of ewes on a different nutritional plane might vary considerably from what I observed. It is probably meaningless to speculate on the specifics of such differences. Such general trends as long and difficult labor, conspicuous inactivity of ewe and lamb, comparative lack of contactual behavior, delayed motor development of lamb, and delayed nursing pattern are all possibilities.

Efforts to quantify the contactual behavior of ewe and lamb might be especially pertinent to this type of comparison. Not only is this type of behavior an index of maternal responsiveness and hence the condition of the ewe, but there is some evidence that such behavior may be involved in the rapid initiation of milk secretion (lactogenesis) soon after birth. The comments of Tindall (1967:88) were very interesting in this respect. He stated:

> ...in addition to the suckling stimulus itself, other sensory modalities may also be involved in the nursing-induced discharge of pituitary hormones. The mere presence of a rat's litter, even though physically separated from the mother, can cause discharge of prolactin from the maternal pituitary..., suggesting the involvement of visual, auditory, or olfactory influences.

In this perspective, the whole spectrum of contactual behavior of ewe and lamb: the intensive licking, the facial nuzzling, even the eating of the placenta and smelling the anal area; could all directly influence the rapid onset of lactogenesis and be a cause as well as an effect of continued maternal responsiveness. This, of course, is not to minimize the importance of other functions suggested by other

researchers for these activities, such as those appearing in Lent's discussion (1966:742-743) of postpartum licking behavior in ungulates. Surely licking may be of great survival value during times of severe weather conditions in the windy, mountain environment where lamb are born, also. Hersher et al. (1963:209) discussed this problem in relation to domestic sheep.

> Drying of the lamb is likely to be more vital under cold, wet, and windy conditions, when the lamb may expend up to 70 kg cal each hour. Much of this energy is utilized to maintain body temperature, which drops at birth and normally rises within a few hours. After 2 or 3 hours, the total energy used may amount to a substantial proportion of the estimated initial energy reserves (600 to 900 kg cal) according to Alexander (1958).

Postpartum pawing:

The ewe's pawing of the lamb in the period 10 minutes or so after birth, which was observed in this study, is an interesting modification of maternal behavior. I know of no comparable observations in the birth behavior of other ungulates, although a comment by Hediger (1955:90) suggested the general pattern may not be unique to sheep.

> I have repeatedly seen for myself how ungulate mothers tapped their weakly young with their forefeet, if they had not got up by the normal time, i.e. within half an hour. This encouragement clearly brought about fresh efforts on the part of the baby. In one case I watched a chamois mother carefully put her horns under her weak kid, and try to raise it that way.

Perhaps when speculating as to the "why" of this behavior, it is well to keep in mind a comment by Lehrman (1961:1311-1312) concerning the interaction between mother and young at birth.

> The behavior of the young is, of course, also characteristic of the species, both because of differences between the young themselves and because of differences in the situation in which they are placed by the varying behavior of the mother. This leads to different kinds of interaction between young and mother in different species at the earliest stages of parturition and prenatal care.... Clearly the behavior of the immediately postparturitive mother and that of the neonate must be adapted to each other.

Lent's discussion (1966:743) of possible modifications of maternal behavior among Cervids in response to the environment where the young are born (whether in open country such as plains or tundra or in afforested areas) offers further evidence of the value of this type of thinking. Thus, the parturient ewe's retreat to the high cliffs for lambing, although affording the utmost protection from disturbance either by other sheep or predators, also poses some unique difficulties for the newborn lamb. Surely the loose shale and scree slides of such areas offer the most difficult footing possible on which to develop motor abilities. One might expect the development of these abilities to be somewhat slower in lambs than in other ungulates born on more favorable terrain, because the cliff environment may physically limit the speed of motor development. I doubt if such acceleration of motor development, as seen in the wildebeest (Talbot and Talbot, 1963: 47), could evolve in a cliff environment, even if there were survival value in such acceleration. Perhaps the postpartum pawing is an adaptation to cliff-dwelling; this pawing may accelerate motor development as much as is possible in the difficult terrain. Without this stimulus delayed motor development might delay the initiation of nursing and, thus, prejudice the lamb's chances of survival. Surely the cliff environment has a profound effect on the behavior profile of ewe and

lamb during the entire first day after birth. The long time that ewe and lamb remain in the isolation of the high cliffs attests to the security that the cliffs afford and contrasts with the behavior of caribou and wildebeest where survival seems to depend on synchrony with the herd as soon as possible after birth. Lent (1966:714) noted:

> In all cases where long observations were obtained with undisturbed pairs, the cow attempted to travel within 4 hours after giving birth and elicited following in calves that had not yet fully attained the motor ability to keep pace.

Maternal imprinting:

Smith et al. (1966) studied the attachment of ewes to their lambs in several breeds of domestic sheep. They found that a period of licking and nuzzling of about half an hour was necessary for ewes to develop the ability to discriminate the lamb so treated from others. This licking occurred more readily if the lambs were still wet with birth fluids. They concluded (p. 124):

> ...it does appear that something analogous to a process of imprinting based on gustatory or olfactory impressions, does take place in ewes and that for the breeds studied, a period of 20-30 min is required for the imprint or impression to be acquired or learned. The acquirement is probably enhanced if the ewe is in relative isolation and not presented with other impressions in the period immediately after birth. In natural circumstances, the very strong tendency of the ewe to draw apart from the flock and to stay on the area covered by the first flow of liquid from the uterus would increase the chances of finding the lamb and of acquiring the impression or imprint with greatest clarity (see Smith, 1965).

Lent (1966:733) found that a similar period of contact of at least half an hour was necessary "...to insure return and searching of the cow" in eartagging operations. Surely any future eartagging operations on newborn Dall sheep should respect this essential development.

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